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1 OF 5

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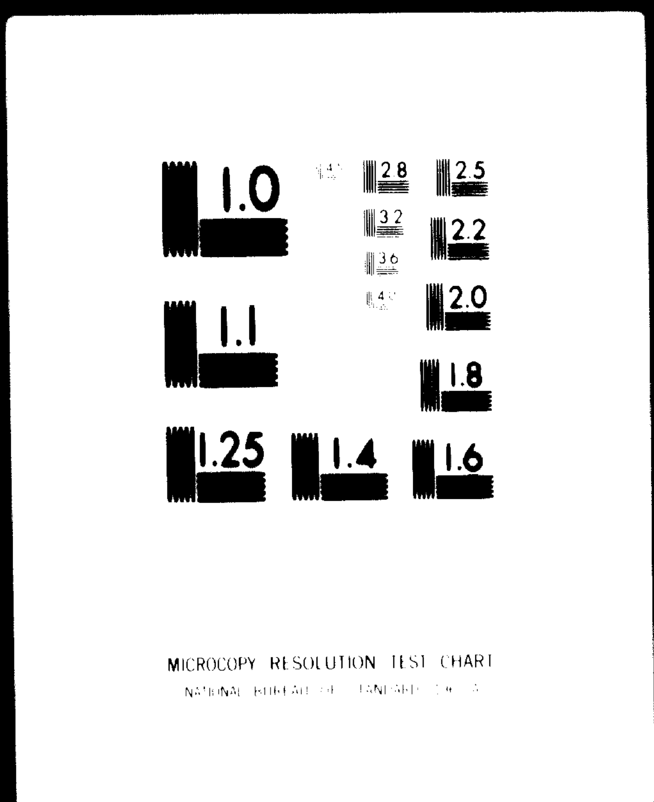

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REPORT

TO

THE UNITED NATIONS INDUSTRIAL DEVELOPMENT ORGANIZATION

ON

THE HELWAN IRON AND STEEL PLANT
THE ARAB REPUBLIC OF EGYPT

SEPTEMBER 1972

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15th September 1972
519-132A

Chief, Technical Equipment Procurement
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United Nations Industrial Development
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REPORT ON HELWAN IRON AND STEEL PLANT

Dear Sir,

We have pleasure in submitting our report in thirty (30) copies on the reconstruction of the Thomas converter shop at the Helwan steel plant, in compliance with the provisions of Contract No. 71/64 (Project SIS/70/1125) of 18th October 1971, subsequently modified by Amendment 1 of 18th November 1971, Amendment 2 of 18th January 1972 and letter TP/MM/jml dated 21st March 1972.

Background

The Helwan iron and steelworks of the Egyptian Iron and Steel Company (HADISOLB) is one of the nine metallurgical units functioning under the Egyptian General Organisation for Metallurgical Industries (EGOMI). The original facilities were commissioned between 1958 and 1960 and the operations were based on the use of high-phosphorus iron ore from the Aswan mines for the production of hot metal in blast furnaces and refining the high-phosphorus metal in Thomas converters. The ingot steel production during the recent years has been averaging 245,000 tons which includes about 45,000 tons of electric furnace steel.

To meet the rising demand for steel, HADISOLB is currently expanding the steel plant with bilateral assistance from the USSR. The expansion is being implemented in two stages for adding a total crude steel capacity of 1.2 million tons of which 0.6 million tons is planned for the first stage. The entire expansion programme is based on the use of low-phosphorus Bahariya ore for ironmaking and LD converters for steelmaking. The use of Aswan ore will be discontinued and the existing blast furnaces will also switch-over to Bahariya ore.

As the low-phosphorus iron will not be suitable for refining in the existing Thomas converters, HADISOLB is examining the possibilities of reconstructing the Thomas shop to enable the use of low-phosphorus iron and at the same time to step up the production to about 330,000 tons of ingot steel per year apart from the anticipated production of 50,000 tons from the electric furnaces.

This study, commissioned by the United Nations Industrial Development Organisation (UNIDO), examines in detail the various possible alternative schemes for reconstruction of the Thomas converter shop on the basis of sound techno-economic parameters including the capital and operating costs. The possibility of refining the low-phosphorus hot metal in the LD converters of the expansion complex has not been considered on the specific advice of HADISOLB to treat the existing plant separate from the complex.

The report seeks to provide the Government of the Arab Republic of Egypt with the basic information and technical data to enable them to take appropriate decisions on the reconstruction of the Thomas converter shop.

Alternative schemes considered

After an on-the-spot study of the existing steelmelt shop facilities and operating practices, five alternative schemes have been evolved for the reconstruction of the Thomas shop, utilising as far as possible the existing equipment and facilities. The alternative schemes are:

- Alt. 1 - Reconstruction with LD converters
- Alt. 2 - Augmenting production from the existing Thomas converters
- Alt. 3 - Installation of larger capacity Thomas converters
- Alt. 4 - Changeover to OBM (Q-BOP) process
- Alt. 5 - Installation of basic side-blown converters

Alternative 1 envisages the installation of three 20-ton LD converters (two operating) to produce about 380,000 tons of ingots per year. The Thomas converters and the electric arc furnaces will be dismantled.

Alternative 2 proposes to augment the production from the existing Thomas converters by providing appropriate balancing facilities which would enable the continuous operation of two of the four converters on a sustained basis to produce about 330,000 tons of ingots annually. High-phosphorus hot metal would be obtained by adding phosphate rock to the blast furnace charge containing the low-phosphorus Bahariya ore. The existing electric arc furnaces will continue to make about 50,000 tons per year.

Alternative 3 visualises the replacement of the existing 17-ton Thomas converters by four new 24-ton Thomas converters (two in operation) and the use of oxygen-enriched blast. High-phosphorus hot metal would be obtained by adding phosphate rock to the blast furnace charge containing the low-phosphorus Bahariya ore. About 380,000 tons of ingots will be produced annually.

Alternative 4 is based on the adoption of the OBM (Q-BOP) process which is suitable for refining both high-phosphorus and low-phosphorus hot metal. This process has been recently developed in West Germany and has been successfully employed in several Thomas converter shops for refining high-phosphorus iron and boosting the production. The process involves the blowing of oxygen and propane (or other suitable hydrocarbons) through the bottom of the converters, the propane providing an endothermic shielding to protect the tuyeres and the bottom lining against high temperature. Powdered lime is injected along with oxygen. The US Steel Corporation has recently decided to install two 200-ton OBM converters at its Fairfield Works in Alabama to refine low-phosphorus iron.

The change over to this process at Helwan can be effected by minor modifications to the existing Thomas converters. The charge weight can be increased by about 30 per cent with corresponding increase in the output. Three of the existing four Thomas converters will be modified. With two operating converters, about 380,000 tons of steel ingots will be produced annually. The fourth Thomas converter and the existing electric furnaces can be retired.

Alternative 5 considers the installation of basic side-blown converters. Generally, converters of this type in small sizes up to 10-ton capacity are used in foundries. However, as suggested by UNIDO, this alternative has been developed for appraisal along with the other alternatives.

It is proposed to install in this scheme four 28-ton side-blown converters in place of the existing Thomas converters to produce about 330,000 tons of ingots annually. The electric arc furnaces would continue to produce about 50,000 tons per year.

15th September 1972
519-132A

Major modifications and additional facilities

The major modifications and additional facilities required as well as the existing facilities to be retained for the various alternative schemes are discussed in detail in the report. The requirements of services and utilities such as lime, oxygen, electric power and water have been estimated for each alternative and appropriate modifications and additions to the existing facilities indicated. These modifications and additional facilities have been arrived at after a detailed investigation, keeping in view the need for minimising the investment cost. Efforts have been made to utilise the existing facilities to the maximum extent and to salvage as much of the dismantled materials and equipment as possible.

Implementation schedule

As the reconstruction of an operating plant is a complex task and would entail interruption to and shut-down of the present operations and consequent loss of production, it is necessary to so plan the work as to minimise the shut-down period, and re-commission the shop as early as possible. For this purpose, a critical path network has been developed for each alternative involving 90 to 140 groups of activities. These networks would assist in proper appraisal of the cost implications, identify critical areas and possible bottlenecks, and provide guidelines for implementing the selected scheme.

The network analysis reveals that the overall implementation period for Alternatives 1, 3 and 5 would extend to 35 to 36 months as against 26 to 27 months for Alternatives 2 and 4. This includes shut-down periods of 23 to 24 months for Alternatives 1, 3 and 5 and 3 to 4 months for Alternatives 2 and 4. During the shut-down period, it may be possible to keep the blast furnaces and the rolling mills in operation by appropriate planning by HADISOLB for the sale of pig iron and procurement of ingots, blooms and billets for rolling.

Capital cost estimates

The capital cost estimates take into account various items of cost such as dismantling, modification and reconstruction of existing facilities and auxiliaries, installation of new equipment and facilities, engineering services, contingencies as well as losses arising from the shut-down of operations during reconstruction. The total capital cost estimates computed on this basis are as follows:

15th September 1972
519-132A

		Local currency '000 $	Foreign currency '000 $	Total '000 $
Alt. 1	..	11 737	5 369	17 106
Alt. 2	..	3 502	1 227	4 729
Alt. 3	..	5 701	2 843	8 544
Alt. 4	..	4 881	3 700	8 581
Alt. 5	..	5 361	2 324	7 685

Operating costs

Tentative manpower estimates have been made mainly to arrive at the labour component of the operating cost for the alternative schemes. As compared to the present strength of 1,070 in the steelmelt shop, the manpower requirements for the various alternatives and the corresponding labour cost, are estimated as follows:

		Manpower requirements	Annual wage bill '000 $	Average manpower cost/ton of ingot $
Alt. 1	..	824	589	1.55
Alt. 2	..	1 092	781	2.05
Alt. 3	..	1 000	715	1.88
Alt. 4	..	789	564	1.48
Alt. 5	..	1 005	719	1.89

The estimated operating costs at the rated capacity for the various alternatives are as follows:

		Operating cost	
		'000 $/year	$/ton ingot
Alt. 1	..	30 339	79.80
Alt. 2	..	33 924	89.30
Alt. 3	..	32 524	85.59
Alt. 4	..	30 198	79.47
Alt. 5	..	34 294	90.25

However, the operating costs during the reconstruction and gestation periods would depend upon the level of production estimated to be attained in the initial years for the various alternatives, and these are computed accordingly for each alternative for the purpose of financial evaluation.

Financial evaluation

The financial evaluation covers the reconstruction period as well as a 20-year period of operation from the year of re-commissioning of the facilities. The unit cost at rated capacity for each alternative is estimated. The fixed charges comprise depreciation at 5 per cent per annum on the additional investment in buildings and equipment, amortisation of project expenses at the rate of 5 per cent per annum and interest on working capital at 8 per cent per annum. The present worth of capital and operating outlays and pay-back period have been arrived at assuming a discount rate of 7 per cent.

The results of financial evaluation are summarised below:

	Unit	Alt.1	Alt.2	Alt.3	Alt.4	Alt.5
Fixed investment a/	mill $	17.37	4.77	8.83	8.62	7.94
Unit cost at rated capacity including fixed charges	$/ingot ton	87.36	93.08	90.54	84.08	95.03
Present worth of capital and operating outlays	$/ingot ton	85.29	90.98	88.52	82.27	93.24
Internal rate of return	%	14	5	12	25	Negative
Pay-back period	years	9	40	10	4	Negative

a/ Excluding capitalised interest charges during construction and replacement.

The above analysis reveals that Alternative 4 based on the OBM (Q-BOP) process is the most attractive from the financial angle. The next in order is Alternative 1 adopting LD converters. This is followed by Alternative 3 employing larger (24-ton) Thomas converters. Alternative 2 which envisages augmenting Thomas steel production from the existing converters and retention of the electric furnaces ranks fourth. Alternative 5, using side-blown converters and retaining the electric arc furnaces is the most uneconomical.

Conclusions

Before finally selecting the most suitable alternative, besides the financial evaluation, it is also necessary to consider other factors such as the status of the process; the flexibility of the process in regard to the types of hot metal that can be refined and the amount of scrap that can be melted; the quality of steel that can be produced; the actual period of shut-down of the production units during the reconstruction time; and the production loss during such shut-down. The merits and demerits of the various alternatives have been compared in the light of these techno-economic considerations.

It will be observed that Alternative 4 which envisages changeover to the OBM process is not only financially the most attractive but is acceptable in other respects also.

The OBM process, though a recent innovation, is already proven and is gaining rapid commercial acceptance. The total world capacity including the capacity under installation is estimated at over 14 million tons. Bulk of this capacity has been created by modifying Thomas converter shops to OBM operations. The OBM process has been adopted already in 10 Thomas converter shops. The US Steel Corporation is installing two 200-ton OBM (Q-BOP) converters in the existing open-hearth shop at their Fairfield Works.

In fact the US Steel has found the process to be attractive enough that half-way through the construction of the new LD shop at Gary, they are changing the 200-ton LD vessels to OBM converters. The Sydney Steel Corporation in Canada are reported to be replacing the existing open-hearth with 120-ton OBM (Q-BOP) converters. The Surahammars Bruks in Sweden are installing a 40-ton OBM converter. From the trend, it appears that the OBM process will make increasing inroads into the field of steelmaking.

In regard to the versatility of the process, the OBM can refine both low-phosphorus and high-phosphorus hot metal whereas the LD is suitable for only low-phosphorus iron and the Thomas converter can refine only high-phosphorus iron. The OBM process can also use higher percentage of scrap in the charge than the LD. The quality of OBM steel is reported to be much superior to the Thomas steel and comparable to open-hearth and LD steel qualities.

Conversion of the Helwan Thomas converter plant to the OBM process will not call for extensive modifications. Further, the actual shut-down period required for conversion of the existing steelmelting operations is estimated to be about four months only

15th September 1972
519-132A

and the loss of production during the shut-down period would be approximately 67,000 tons which is not excessive. The manpower requirement for the OBM operation is the lowest of all the alternatives. Moreover, as the production obtainable from the OBM converters is about 380,000 tons of ingot steel, the arc furnaces could be shut down.

In view of the above considerations, Alternative 4 adopting the OBM process is recommended as a suitable scheme for reconstructing the existing Thomas converter shop to refine iron produced from Bahariya ore and to meet the proposed production requirements.

It needs to be emphasised that the cost data and implementation schedules presented in this report are only indicative of the order of magnitude for the purpose of evaluation of the various alternatives. For the OBM process, the cost figures and the process parameters given in this report are based on published information. Details of these are not available, as they are precluded from public discussion by non-disclosure agreements between the promoters, licencees and operating companies. Before implementing the project, it will be necessary to enter into a suitable collaboration arrangement with the promoters of the OBM process to obtain the process know-how and guarantees, and to define the costs more precisely.

We would like to take this opportunity to express our grateful thanks for the help and assistance extended by UNIDO, UNDP (Cairo), EGOMI, HADISOLB and other organisations and individuals in carrying out this study.

Respectfully submitted
DASTUR ENGINEERING INTERNATIONAL GmbH
by

M.N. Dastur

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TABLE OF CONTENTS

TABLE OF CONTENTS
(continued)

TABLE OF CONTENTS
(continued)

TABLE OF CONTENTS
(continued)

TABLE OF CONTENTS
(continued)

TABLE OF CONTENTS
(continued)

Page

TABLES (Cont'd)

TABLE OF CONTENTS
(continued)

Page

TABLES (Cont'd)

TABLE OF CONTENTS (continued)

TABLE OF CONTENTS
(continued)

Page

APPENDICES (Cont'd)

DRAWINGS

TABLE OF CONTENTS
(continued)

EXPLANATIONS

Three dots (...) indicate that data are not available or are not separately reported.

A dash (-) indicates that the amount is nil or negligible.

A plus sign (+) indicates a surplus or an increase.

A minus sign (-) indicates a deficit or decrease.

A full stop (.) indicates decimal.

A space between numerals is used to distinguish thousands and millions (1 346 849).

A stroke (/) indicates a crop year or fiscal year, e.g. 1953/1954. The fiscal year adopted is from 1st July through 30th June.

'To' between the years indicates the full period, e.g. 1960 to 1964 means inclusive of the years 1960 and 1964.

Details and percentages in tables do not necessarily add up to totals, because of rounding.

Reference to 'tons' indicates metric tons, and to 'dollars' United States dollars, unless otherwise stated.

Conversion rate adopted is £E 1 = $ 2.33.

SUMMARY AND CONCLUSIONS

INTRODUCTION

1. This study has been prepared in accordance with the final and amended terms of reference of the contract with the United Nations Industrial Development Organization (UNIDO). The relevant excerpts from the contract and the subsequent amendments are given in Appendix 1-1.

2. At present, the Helwan steel plant is smelting high phosphorus Aswan ore in two small blast furnaces and the high phosphorus hot metal is refined in Thomas convertors. The highest production achieved so far from the steelmelt shop is 255,971 tons of ingots in the year 1968/69 comprising 205,573 tons from the Thomas convertors and 50,398 tons from the electric arc furnaces.

3. The Soviet-aided expansion programme, planned for an additional capacity of 1.2 million tons of crude steel, is under implementation. The new blast furnaces will use low-phosphorus Bahariya iron ore and produce low-phosphorus hot metal which will be refined in LD convertors.

Summary and conclusions (cont'd)

4. With the switch-over to Bahariya ore in the expansion programme, the existing blast furnaces also have to use the same ore. The low-phosphorus hot metal produced cannot be refined by the Thomas process.

5. The possibility of refining this hot metal in the LD converters of the expansion complex has not been examined in this study on the specific advice by the Helwan steel plant authorities to consider the existing plant separate from the complex. The purpose of this study, according to the terms of the contract, is to evolve a suitable scheme for reconstructing the Thomas converter shop with a view to produce 330,000 tons of ingot steel in addition to 50,000 tons from the electric furnaces. It is, therefore, necessary to study the technological ways and means of refining the low-phosphorus iron by selecting a suitable process technology and by making necessary modifications to the facilities in the existing Thomas converter shop.

6. The background and aim of the project as well as the statement of work according to the final and amended terms of reference are given on the next page along with the references to the discussions made thereof in the various portions of this report in order to facilitate easy reference.

Summary and conclusions (cont'd)

Reference to contract	Reference to Summary and conclusions		Reference to text	
	Page No.	Para No.	Chapter No.	Page No.
1.01 Background				
At present high-phosphorus iron produced from Aswan ore is being refined into steel in the Thomas converter shop	1 5-7	2 8-12	1 2	1-1 to 1-3 2-1 to 2-25
The steelworks is being expanded (through bilateral assistance of USSR) to a crude steel annual capacity of about 1.5 million tons using the LD process to refine the low-phosphorus iron produced from Bahariya ore	1 8 & 9	3 13-16	1	1-4 to 1-6
The low-phosphorus pig iron from Bahariya ore cannot be refined into steel by the Thomas converter process. It is, therefore, necessary to study the technological ways and means of utilising existing Thomas converter shop facilities	9-10	17-19	3	3-2 to 3-7
It is necessary to comprehensively examine the various alternatives on sound techno-economic parameters including capital and operating costs of implementing them	15-17	34-37	3	3-7 to 3-8
1.02 Aim of the project				
To provide basic information and technical data on the possible utilisation of existing Thomas steelmelting shop which will become redundant when the projected switch-over is made from Aswan iron ore to Bahariya iron ore for iron smelting. The reconstructed Thomas shop is expected to produce about 330,000 tons of steel ingots per annum using Bahariya ore.	18-20	39-43	3	3-8 to 3-26

Summary and conclusions (cont'd)

Reference to contract	Reference to Summary and conclusions Page No.	Para No.	Reference to text Chapter No.	Page No.
2.01 Statement of work				
The reconstruction of the steelworks and the replacement of the Thomas converters by LD converters	18	39	4	4-1 to 4-8
The modification of the existing Thomas converter in order to raise the capacity from 17-ton/heat to 20-25 tons/heat	19	41	4	4-11 to 4-14
Any acceptable alternative proposal appropriate as a solution				
Augmenting production from existing Thomas convertors a/	18	40	4	4-8 to 4-11
Adoption of OHM process a/	19-20 27-33	42 58-74	4	4-14 to 4-16
Side-blown convertors a/	20	43	4	4-16 to 4-20
Determine and recommend after critical examination the best techno-economic alternative	21-27	44-56	4,5,6,7, 8 and 9	Complete chapters
Estimate the capital and operating cost for the recommended alternative	41-50	92-111	7 and 8	Complete chapters
Suggest a tentative plan of implementation for this alternative to serve as a basis for further action by the Egyptian Organization for Metallurgical Industries	34-41	75-91	6	Complete chapters

a/ Other alternative proposals considered.

BACKGROUND TO THE STUDY

7. The Helwan steelworks of the Egyptian Iron and Steel Company (HADISOLB), commissioned between 1958 and 1960, is the only integrated steel plant in the Arab Republic of Egypt. HADISOLB is one of the nine metallurgical units functioning under the Egyptian General Organisation for Metallurgical Industries (EGOMI) which is the planning and co-ordinating body for the metallurgical industry in the country.

Raw materials supply

Raw materials in use

8. The steel plant uses high-phosphorus iron ore from the mines near Aswan for ironmaking in blast furnaces. The hot metal is refined into steel in Thomas converters. Limestone is obtained from the quarries at Refaii. Initially, the blast furnaces were operated with imported coke from Europe. Since 1964, however when the coke ovens were installed adjacent to the steelworks, coal is imported from the Soviet Union and Poland.

Existing facilities

9. The Helwan steel plant commenced operations with two 5.1 m hearth dia blast furnaces, three 17-ton

Summary and conclusions (cont'd)

Thomas convertors, two 12-ton electric arc furnaces and a rolling mill complex comprising a 900 mm blooming and slabbing mill, one 3-stand 750 mm medium section mill, one 1,800 mm wide 3-high plate mill and a 1,250 mm 2-high sheet mill. A 550 mm light section mill and a 50 sq m sintering machine were added in 1964.

10. The annual rated capacity of the initial steelmaking facilities was 265,000 tons of steel ingots, comprising 229,000 tons of Thomas steel and 36,000 tons of electric furnace steel. However, as the actual production from the Thomas convertors was considerably lower than the rated capacity, certain ancillary facilities were added from time to time to improve the output. Despite these efforts, the maximum production achieved till 1965/66 from the Thomas convertors was only 158,640 tons in 1962/63. On the other hand, the arc furnaces exceeded the rated capacity and produced 41,977 tons in 1965/66.

11. In order to step up the Thomas steel production, a fourth convertor of identical capacity was installed in March 1967. During the subsequent years, some

Summary and conclusions (cont'd)

balancing facilities such as overhead cranes, bottom-baking ovens etc were added. Though there was a marked increase in production after these additions, the average for the past 4 years was only about 198,000 tons which was still short of the original rated capacity of 229,000 tons.

Production achieved

12. The highest production achieved so far by the Thomas converters was 205,573 tons in 1968/69. In the same year, the electric furnaces also made a record production of 50,398 tons, the total being 255,971 tons. The total steelmelt shop production from 1959 to 1970/71 is shown in Table 1.

Table 1

INGOT STEEL PRODUCTION

Year[a]		Thomas converters tons	Elec.arc furnaces tons	Total tons
1959	..	92 821	19 185	112 006
1960	..	111 784	24 385	136 169
1961	..	128 617	27 552	156 169
1962 (Jan-June)		70 394	8 056	78 450
1962/63	..	158 640	34 471	193 111
1963/64	..	154 824	38 757	193 581
1964/65	..	148 171	41 539	189 710
1965/66	..	142 794	41 977	184 771
1966/67	..	164 188	45 022	209 210
1967/68	..	198 280	48 801	247 081
1968/69	..	205 573	50 398	255 971
1969/70	..	197 186	46 555	243 741
1970/71	..	191 194	42 740	233 934

a/ Calendar year till 1961 and fiscal year (July to June) from 1962/63 onwards.

Summary and conclusions (cont'd)

Expansion programme

13. It will be noted that the annual steel production over the past four years has averaged 245,000 tons. To meet the rising demand for steel, HADISOLB is currently implementing an expansion programme with Soviet assistance, to raise the total crude steel capacity to 1.5 million tons.

Two-stage expansion

14. The expansion is being carried out in two stages. In the first stage, which is expected to be completed by mid-1973, 0.6 million tons of crude steel capacity will be added. At full development scheduled to be completed by mid-1975, the additional capacity will be raised to 1.2 million tons.

New production facilities

15. The major production facilities to be installed in the first stage are one 1,033 cu m blast furnace, two 75 sq m sintering machines, two 80-ton LD converters, two 2-strand slab casting machines and one 6-strand billet casting machine. During the full development stage, additionally one blast furnace, two sintering machines, one LD converter, one slab casting machine and two billet casting machines of identical sizes will be installed.

Summary and conclusions (cont'd)

Switch-over to Bahariya ore

Use of Bahariya ore

16. Iron production after expansion will be based on the use of low-phosphorus Bahariya iron ore. About 1.75 million tons of hot metal will be produced annually, including 410,000 tons from the two existing blast furnaces. Of this, 1.2 million tons would be consumed in the new LD shop, and it was intended that about 300,000 tons would be used in the existing Thomas shop, leaving 248,000 tons for sale.

Reconstruction of Thomas shop

Capacity of reconstructed Thomas shop

17. However, during discussions with HADISOLB, the Consulting Engineers were advised that the Thomas shop when reconstructed should be capable of producing 330,000 tons of ingot steel per year, excluding the electric furnace production, and that no additional scrap would be available for the Thomas shop. For the purpose of this study, it was further indicated that the existing plant may be considered independent of the new complex.

Low-phosphorus iron not suitable for Thomas process

18. As the low phosphorus hot metal produced from Baharia ore will not be suitable for the Thomas process, it would be necessary to study the technological ways and means of reconstructing the Thomas converter shop to enable the use of low phosphorus hot metal and at the same time to step up the production to 330,000 tons per year.

Summary and conclusions (cont'd)

19. In connection with the preparation of this report, the Consulting Engineers deputed their experts to the Helwan steel plant for on-the-spot study of the existing steelmelt shop facilities and operations. A series of discussions were also held by the team with EGOMI, HADISOLB as well as UNIDO.

EXISTING STEELMAKING PRACTICE

Steelmaking raw materials

20. The high-phosphorus hot metal produced from Aswan ore is refined in the Thomas convertors. The electric arc furnaces use scrap as melting stock. Other raw materials include burnt lime, fluorspar, mill scale and ferro-alloys. The annual raw material consumption in the steelmelt shop for the year 1970/71 is given in Table 2.

Table 2

ANNUAL RAW MATERIAL CONSUMPTION IN STEELMELT SHOP 1970/71
Ingot steel production: Thomas - 91,194 tons
Electric - 42,740 tons

Raw materials		Thomas convertors tons	Electric furnaces tons	Total tons
Hot metal	..	241 927	-	241 927
Scrap	..	1	47 663	47 664
Mill scale	..	-	1 616	1 616
Burnt lime	..	38 797	1 534	40 331
Fluorspar	..	13	89	102
Ferro-alloys	..	4 271	379	4 650

Summary and conclusions (cont'd)

Converter operation

21. The converter charge contains approximately 18 tons of hot metal and the requisite amount of lime. The blow lasts for about 14 minutes to 16 minutes, depending upon the analyses of the hot metal. The charge-to-tap time averages 38 minutes. The yield of good ingots is about 80 per cent of the hot metal charge.

Electric furnace practice

22. In the electric furnace steelmaking, the nominal charge weighs about 13 tons per heat and the heat time varies from 3 hours to 3½ hours. The yield of good ingots from the metallic charge is about 86.5 per cent.

Steel grades and casting practice

Steel grades

23. At Helwan, the bulk of the steel produced in the Thomas converters is low carbon rimming quality for structural grades. In the electric furnaces, rimming, semi-killed and killed steels are made. About 85 per cent of the production consists of low carbon and mild steels and 15 per cent, medium and high carbon.

Ingot sizes and mould life

24. Thomas steel is top-poured into 3.3-ton and 4-ton square ingots, whereas the electric furnace steel is generally bottom-poured into 1-ton, 1.5-ton and 2-ton slab ingots. In 1970/71, the average life of

the square moulds was about 45 heats for K-40 type and 50 heats for K-33 type; and that of slab moulds 20 heats, 22 heats and 16 heats for types B-20, B-15 and B-10 respectively.

Lining life

Thomas converter lining

25. The average life of the tar-bonded dolomite brick lining of the Thomas converters varies from 140 heats to 180 heats. The bottom life varies from 22 heats to 31 heats. In 1970/71, the average life of the converter lining was 164 heats and bottom lining 27 heats. The average relining time was 81 hours and bottom changing time 11.66 hours.

Electric arc furnace lining

26. The arc furnace lining consists of tar dolomite rammed bottom, side walls of tar dolomite bricks and silica roof. The average life of the bottom is 300 heats, side wall 50 heats and roof 65 heats. The approximate relining time is 116 hours and roof changing time 5 hours.

Operating problems

Shortfall in Thomas production

27. While the arc furnaces have demonstrated their ability to produce around 50,000 tons per year (substantially higher than the rated capacity of 36,000 tons), the Thomas converter output has

averaged only 198,000 tons over the past four years against the original rated capacity of 229,000 tons, in spite of the addition of a fourth converter and other facilities. Deficiencies in the layout and facilities, as well as operating and maintenance problems prevent any substantial rise in the present production level of the shop.

Impediments to production

28. The number of heats from the Thomas converters average 38 per day. One of the major bottlenecks in the way of increasing the number of heats is the casting car. With a total cycle of 35 minutes per heat, the casting car is not able to cope with more than an average of 40 heats per day on a sustained basis. Moreover, when the casting car is inoperative, no alternative arrangement is available for tapping the heat.

29. A second problem is the limited supply of air blast. At present, even when two converters are available, only one is blown and the other remains idle. If the number of heats per day were to be increased, simultaneous blowing of two converters would become necessary on many occasions, depending on the operating conditions.

Summary and conclusions (cont'd)

30. A third reason for production delays is the extremely congested working conditions in the casting aisle. Adequate space and facilities are not available for mould storage and preparation, casting and stripping, and despatch of ingots.

Delay analysis

31. The delay analysis given in Table 3 reveals that out of 14,800 converter hours available for production during the year, the actual number of converter hours worked is only 9,000. Out of the delay of 5,800 converter hours, about 3,500 to 4,200 converter hours are on account of delays in converter charging which could have arisen mainly because of the limitations of the casting car and the blowing equipment, besides minor repairs to the converter lining etc.

Table 3

THOMAS SHOP DELAY ANALYSIS

	Hours per year		
	1968/69	1969/70	1970/71
Total available converter hours in the year ..	35 040	35 040	35 040
Relining and repairs ..	20 446	20 225	20 224
Converter hours available for operation ..	14 594	14 815	14 816
Delays:			
Production delays (charging, lining repair etc) ..	3 800	4 241	3 474
Shortage of iron/additions..	409	724	903
Hydraulic system ..	52	-	-
Mechanical ..	558	482	762
Electrical ..	90	142	495
Power failure ..	13	37	10
Others ..	304	122	256
Total delays ..	5 226	5 748	5 900
Annual converter hours worked	9 368	9 067	8 916

Major modifications required

32. It should be possible to reduce the delays, by better coordination of the operations and improved maintenance. However, under the existing limitations, it may be difficult to step up the Thomas production beyond 225,000 tons. Therefore, for augmenting the production to 330,000 tons per year as envisaged by HADISOLB, it would be necessary to reconstruct the steelmelt shop and adopt a suitable process to refine the low-phosphorus hot metal that will be produced from Bahariya ore.

ALTERNATIVE SCHEMES FOR THOMAS SHOP RECONSTRUCTION

33. Keeping in view the above considerations, alternative schemes have been worked out for the reconstruction of the Thomas shop, and wherever possible, the existing equipment and facilities have been retained in order to reduce the investment.

Technological considerations for choice of steelmaking process

Hot metal phosphorus content

34. As the Bahariya ore has a low phosphorus content, the hot metal is expected to analyse about 0.45 per cent of phosphorus. If the present Thomas process is to be continued, the phosphorus content has to be raised to about 2.0 per cent. This can be achieved by adding either phosphate rock or Thomas slag to

the blast furnace charge, or ferro-phosphorus to the hot metal. The addition of phosphate rock to the blast furnace charge is found to be most economical.

LD steelmaking

35. On the other hand, low-phosphorus iron can be refined economically in the LD process. Though the LD-AC and the Kaldo processes can also refine low-phosphorus iron, they are primarily used with high-phosphorous iron and would be more expensive.

OBM (Q-BOP) process

36. A new process of oxygen steelmaking - the OBM process, also known as 'Q-BOP' and 'N-BOP' - has been developed recently in West Germany, which has found initial application in boosting the productivity of Thomas converters and in improving the steel quality. A number of Thomas converter shops in France, Germany, Belgium and Luxembourg have adopted this process. Briefly, the process involves the blowing of oxygen through the bottom of the converter, instead of blowing air as in the conventional Thomas converter. An endothermic shielding is effected by injecting propane or other suitable hydro-carbons to protect

the tuyeres and the bottom lining from high temperature. The LWS process recently developed in France, uses fuel oil in place of propane or hydro-carbons. Powdered lime is injected along with oxygen.

Side-blown convertors

57. The low-phosphorus hot metal could also be treated in basic side-blown convertors, but these are generally not adopted for large-scale steel production, owing to the unfavourable economics. However, at the suggestion of UNIDO, side-blown convertors have been considered as one of the alternatives in this study.

Five alternative schemes considered

58. Five alternative schemes have been considered for the reconstruction of the Thomas shop at Helwan, namely

Alt. 1 - Reconstruction with LD convertors

Alt. 2 - Augmenting production from the existing Thomas convertors

Alt. 3 - Installation of larger capacity Thomas convertors

Alt. 4 - Changeover to OMB (Q-BOP) process and

Alt. 5 - Installation of basic side-blown convertors.

Summary and conclusions (cont'd)

<u>Alt. 1 - Reconstruction with LD converters</u>

39. In Alternative 1, the installation of three 20-ton LD converters (two operating) is envisaged, replacing the existing Thomas converters. On the basis of an average tap-to-tap time of 48 minutes, 60 heats can be made per day from the two operating converters. The annual capacity will be 380,000 tons of steel ingots, assuming 335 operating days per year.

<u>Alt. 2 - Augmenting production from existing Thomas converters</u>

40. In Alternative 2, it is proposed to augment the production of the existing Thomas converters by increasing the total number of heats to 64 per day through continuous operation of two converters and 19-ton hot metal charge per heat. On the basis of a tap-to-tap time of about 45 minutes per heat and 32 heats per day from each converter, it is estimated that about 330,000 tons of ingots will be produced from the Thomas converters. The electric furnaces will continue to operate and produce about 50,000 tons.

Summary and conclusions (cont'd)

Alt. 3 - Larger capacity Thomas convertors

41. In Alternative 3, it is proposed to replace the existing 17-ton Thomas convertors by four new 24-ton convertors, of which two will be in continuous operation, and to use oxygen enriched blast. On the basis of a tap-to-tap time of 48 minutes and 30 heats per day from each operating convertor, and average lining life of 175 heats and two-convertor availability, about 380,000 tons of steel ingots will be produced annually. The electric arc furnaces could be shut-down.

Alt. 4 - Change over to OBM (Q-BOP) process

42. In Alternative 4, three of the four existing Thomas convertors will be modified to adopt the OBM (Q-BOP) process. It is assumed that, with the change over to this process, the charge weight could be raised by 30 per cent with corresponding increase in the convertor output. The tap-to-tap time is estimated at about 45 minutes which will easily give 60 heats per day from both operating convertors. On a conservative basis, it is expected that the lining life would average 200 heats and the bottom life about 100 heats, though much higher figures have been reported. This would

give an availability of two out of the three converters for continuous operation. On this basis, the annual production works out to 380,000 tons of ingot steel assuming 335 operating days per year. The fourth Thomas converter can be retired. Also, as the entire steel production required can be met by the OBM installation, the existing electric arc furnaces can be shut-down.

Alt. 5 - Basic side-blown converters

43. This alternative envisages the replacement of the existing Thomas converters by four 28-ton side-blown converters. The tap-to-tap time is estimated at 57 minutes which would give about 25 heats per day from each operating converter. The lining life is expected to average 70 heats. On this basis, two out of the four converters will be available for continuous operation which will produce 50 heats per day or about 330,000 tons per year, assuming 335 operating days. The existing electric arc furnaces will continue to produce about 50,000 tons per year.

EVALUATION OF ALTERNATIVES

44. In order to select the most suitable alternative for reconstruction of the Thomas shop, the techno-economic aspects of the above five alternatives have been studied in detail. The modifications and additional facilities required are discussed in Chapter 4. Additional requirement of services and utilities viz. burnt lime and dolomite, oxygen, power and cooling water and the new facilities proposed to meet these requirements are dealt with in Chapter 5.

45. The implementation schedule of the reconstruction work involved in each of the alternative schemes is described in Chapter 6. In order to minimise the shut-down period and consequent loss of production, critical path net-works have been developed for scheduling the reconstruction programme under each alternative. These net-works are presented in Drawings 519-6-1 to 519-6-5 in Chapter 6.

46. The capital and the operating costs for all the five alternatives are worked out in Chapters 7 and 8 respectively. The financial evaluation is presented in Chapter 9 on the following criteria of profitability:

Summary and conclusions (cont'd)

i) total annual cost and average cost per ingot ton including incidence of fixed charges on the additional investment;

ii) present worth of capital and operating outlays per ingot ton;

iii) internal rate of return on the additional investment; and

iv) pay-back period of the additional investment calculated on discounted basis.

Results of financial evaluation

47. The results of the financial evaluation are summarised in Table 4 below.

Table 4

RESULTS OF FINANCIAL EVALUATION

	Unit	Alt.1	Alt.2	Alt.3	Alt.4	Alt.5
Fixed investment a/	million $	17.37	4.77	8.83	8.62	7.94
Unit cost at rated capacity including fixed charges	$/ingot ton	87.36	93.08	90.54	84.08	95.05
Present worth of capital and operating outlays	$/ingot ton	85.29	90.98	88.52	82.27	95.24
Internal rate of return	%	14	5	12	25	Negative
Pay-back period	years	9	40	10	4	Negative

a/ Excluding capitalised interest charges during construction.

48. The above analysis reveals that Alternative 4 based on the OBM (Q-BOP) process is the most attractive

from the financial angle. The next in order is Alternative 1 adopting LD converters. This is followed by Alternative 3 employing larger (24-ton) Thomas converters. Alternative 2 which envisages augmenting Thomas steel production from the existing converters and retention of the electric furnaces ranks fourth. Alternative 5 using side-blown converters and retaining the electric arc furnaces is the most uneconomical as the rate of return on investment is negative and the pay-back period is not attained.

49. Before finally selecting the most suitable alternative, besides the financial evaluation, it is also necessary to consider other factors such as the status of the process; the flexibility of the process in regard to the types of hot metal that can be refined and the amount of scrap that can be melted; the quality of steel that can be produced; the actual period of shut-down of the production units during the reconstruction time; and the production loss during such shut-down. The merits and demerits of the various alternatives in the light of these techno-economic considerations are given in Table 5.

Table 5

COMPARISON OF ALTERNATIVE S

Item		Alt. 1 LD Converter	Alt. 2 Existing Thomas Converter
Fixed investment, million ฿	..	17.37	4.77
Unit production cost (including fixed charges), ฿ per ingot ton	..	87.36	93.08
Internal rate of return, per cent	..	14	5
Payback period, years	..	9	40
Annual production from reconstructed Thomas shop, tons	..	380,000	330,000
Heat size (metallic charge), tons	..	23	19
Number of converters	..	3	4
Number of operating converters	..	2	2
Heat time, minutes	..	48	45
No. of heats per converter per day	..	30	32
Yield - metallics to ingot, per cent	..	86	84
Status of process	..	Leading process at present	Almost obsolete
Quality of steel	..	Comparable to open-hearth quality - various grades including low alloy steels are being produced	High nitrogen and inclusion content - all grades of steels cannot be produced
Quality of hot metal	..	Only low-phosphorus hot metal can be used	Only high-phosphorus hot metal can be used
Ability to melt scrap	..	Up to about 30% of charge weight	In small percentage only
Reconstruction time, months	..	36	26
Shut down during reconstruction, months	..	24	3
Loss of steel production during shut down, tons		400,000	50,000
Manpower requirement	..	824	1,092

SECTION 1

Table 5

...N OF ALTERNATIVE SCHEMES

Alt. 2 ...ng Thomas Converter	Alt. 3 24-ton Thomas Converter	Alt. 4 OBM Converter	Alt. 5 Basic side-blown conv.
4.77	8.83	8.62	7.94
93.08	90.54	84.08	95.03
5	12	25	Negative
40	10	4	Negative
...0,000	380,000	380,000	330,000
19	24	22	28
4	4	3	4
2	2	2	2
45	48	45	57
32	30	32	25
84	85	86.5	84
...solete	Almost obsolete	Recent innovation gaining commercial acceptance	Not adopted for tonnage steel production
...ogen and inclusion ... all grades of ...nnot be produced	High nitrogen and inclusion content - all grades of steels cannot be produced	Reported to be superior to Thomas steel and comparable to open-hearth and LD quality	...
...-phosphorus hot ... be used	Only high-phosphorus hot metal can be used	Both high as well as low phosphorus hot metal can be used	...
...ercentage only	Up to about 15% of charge weight depending on the oxygen enrichment of the blast	Up to about 35% of charge weight	...
26	35	27	38
3	23	4	24
...0,000	384,000	67,000	400,000
1,092	1,000	780	1,005

SECTION 2

Summary and conclusions (cont'd)

ALTERNATIVE 4 (OBM PROCESS) RECOMMENDED

50. It will be observed that Alternative 4 which envisages change-over to the OBM process is not only financially the most attractive but is acceptable in other aspects also.

51. The OBM process, though a recent innovation, is already proven and is gaining rapid commercial acceptance. The total world capacity, including the capacity under installation, is estimated at over 14 million tons as detailed in Appendix 3-1. Bulk of this capacity has been created by modifying Thomas converter shops. It will be noted from Appendix 3-1 that the OBM process has been adopted already in 10 Thomas converter shops. The U.S. Steel Corporation is installing two 200-ton OBM (Q-BOP) converters in the existing open-hearth shop at their Fairfield Works.

52. In fact, the U.S. Steel has found the process attractive enough that half-way through the construction of the new LD shop at Gary, they are changing the 200-ton LD vessels to OBM converters. The Sydney Steel Corporation in Canada are reported to be replacing the existing open-hearth with 120-ton OBM converters. The Surahammars Bruks in Sweden are

installing a 40-ton OBM converter. From the trend, it appears that the OBM (Q-BOP) process will make increasing inroads into the field of steelmaking.

53. In regard to the versatility of the process, the OBM can refine both low-phosphorus and high-phosphorus hot metal whereas the LD is suitable for only low-phosphorus iron and the Thomas converter can refine only high-phosphorus iron. The OBM process can also use higher percentage of scrap in the charge than the LD. The quality of OBM steel is reported to be much superior to the Thomas steel and to be comparable to open-hearth and LD steel qualities.

54. Conversion of the Helwan Thomas converter plant to the OBM process will not call for extensive modifications. Further, the actual shut-down period required for conversion of the existing steelmelting operations is estimated to be about four months only, and the loss of production during the shut-down period would be approximately 67,000 tons which is not excessive. The manpower requirement for the OBM operation is the lowest of all the alternatives. Moreover, as the production obtainable from the OBM converters is about 380,000 tons of ingot steel, the arc furnaces could be shut down.

Summary and conclusions (cont'd)

55. In view of the above considerations, Alternative 4 adopting the OBM process is recommended as a suitable scheme for reconstructing the existing Thomas converter shop to refine iron produced from Bahariya ore and to meet the proposed production requirements.

56. It needs to be emphasised that the cost data and implementation schedules presented in this report are only indicative of the order of magnitude for the purpose of evaluation of the various alternatives. For the OBM process, the cost figures and the process parameters given in this report are based on published information. Details of these are not available as they are precluded from public discussion by non-disclosure agreements between the promoters, licencees and operating companies. Before implementing the project, it will also be necessary to enter into a suitable collaboration arrangement with the promoters of the OBM process to obtain the process know-how and guarantees, and to define the costs more precisely.

57. The modifications and additional facilities required for switch-over to OBM (Q-BOP) process, the implementation schedule and the capital and operating costs for the OBM process are discussed in the following paragraphs.

MODIFICATIONS TO ADOPT OBM PROCESS

Annual raw material requirement

58. The annual requirements of major raw materials would be 370,500 tons of low phosphorus hot metal from

Bahariya ore, 56,000 tons of scrap, 7,980 tons of iron oxides, 8,550 tons of ferro-alloys etc and 34,200 tons of burnt lime. The material flow sheet is shown in Drawing 519-0-1.

OBM facilities

59. A tentative layout of the proposed OBM facilities in the steelmelt shop building is given in Drawing 519-0-2. Three of the existing Thomas converters will be modified to adopt the OBM process and the fourth one dismantled. The existing electric arc furnaces as well as the existing blowers will become redundant. The ladle preparation facilities will be dismantled and the ladle aisle will remain unutilised. Facilities for the storage of propane etc, for injecting into the OBM converter, will be provided. The existing Thomas converters will be equipped with modified bottoms for the OBM process.

Modifications to electric furnace aisle and scrap yard

60. The modifications in the electric furnace aisle and the scrap yard include the dismantling of the electric arc furnaces and their ancillary facilities; modification of the existing 16/5-ton overhead crane in the electric furnace aisle into a magnet crane for handling scrap; and the installation of scrap transfer car and tracks.

Summary and conclusions (cont'd)

Modifications in the mixer and charging aisle

61. All the existing casting facilities, including the casting car and casting pit and the mould preparation facilities in the mixer and charging aisle, will be dismantled. The existing 25/5-ton hot metal charging crane will be modified into a scrap charging crane. The 10-ton stripper crane and 25/5-ton casting crane will be dismantled and relocated in the new casting aisle. The space made available from dismantling existing casting and mould handling facilities will be used for storage, cooling and preparation of ingot moulds.

New casting aisle

62. As the existing casting aisle is too congested, a new casting aisle, 170 m long and 22.25 m wide will be constructed, parallel and adjacent to the existing mixer and casting aisle, and suitable facilities for the casting of ingots and stripping of moulds as well as for ladle preparation provided. Two new 50/10-ton casting cranes will be installed in addition to the ladle and stripper cranes relocated in this aisle.

Flux grinding plant etc

63. A flux grinding plant of suitable capacity will be installed in the existing lime aisle, which will be extended by 20 m. The existing lime bunkers will be dismantled and new storage bins for lime and other

fluxes constructed. In addition to the existing dolomite calcining and brick-making facilities an additional brick press will be installed.

Services and utilities

Lime calcining plant

64. The existing lime calcining installation was designed for a total daily production of 140 tons, but the actual production has been around 100 tons per day. The annual requirements of burnt lime is estimated at 34,200 tons. As against this, the annual burnt lime production from the existing plant is about 32,640 tons. Thus, there will be a shortfall of 1,560 tons. This additional requirement of burnt lime can be met by purchases.

Dolomite calcining & brickmaking plant

65. The existing dolomite burning plant consists of two coke-fired vertical kilns, designed for a total daily output of 30 tons. However, the actual output has been much higher, about 45 tons. The annual production is estimated at about 14,850 tons, assuming 330 operating days. But allowing 5 per cent loss, the net availability will be about 14,100 tons. However, the annual requirement is only 7,860 tons. Hence the existing dolomite calcining plant can easily meet the entire demand.

Summary and conclusions (cont'd)

66. The existing tar dolomite preparation facilities will be adequate to meet the requirement of the modified steelmelt shop. In the case of dolomite bricks, however, there will be a shortfall of 1,200 tons per year. For meeting this increased demand of tar dolomite bricks, additional brickmaking facilities will be installed.

<u>Oxygen plant</u>

67. Oxygen is required for steelmaking by the OBM process. The annual requirement is 32,600 tons giving an average daily requirement of 104 tons with a maximum flow rate of 4,960 cu m per hour. It is proposed to install an oxygen plant of 125 tons/day capacity. The purity of oxygen produced will be over 99.5 per cent. Liquid oxygen storage with vapourisation facilities will be provided to augment the oxygen supply during emergency shut-downs. Provision is also kept for the generation of 99.5 per cent pure nitrogen. The discharge pressure of the oxygen compressor will be 15 kg/cm^2/g and suitable buffer vessels will be provided to take care of the peak demands.

<u>Power distribution system</u>

68. The power is supplied at 63 kV to the steel plant from the Cairo South Power Station (thermal) which is connected through 63 kV grid to the El Tabbin

(Thermal and gas) station. The plant has two step-down stations, one having 4 x 20 MVA, 63/6.6 kV transformers feeding the rolling mill complex, blast furnaces and steelmelt shop; and the second with 4 x 25 MVA, 63/6.6 kV transformers for the strip mill.

69. The overall estimated power requirement of the steelmelt shop is given in Table 6.

Table 6

ESTIMATED POWER REQUIREMENTS

30 min maximum demand	..	6.0 MW
Total annual energy consumption		35 million kWh
Overall power factor	..	0.85

New sub-station proposed

70. As the arc furnaces would be shut down, surplus power would be available on the system as a whole. It is proposed that the two arc furnace feeders be used to establish a new sub-station located adjacent to the oxygen plant, for the new plant loads. The sub-station would also feed the additional load centre sub-stations required for auxiliary loads.

Summary and conclusions (cont'd)

Load-centre sub-stations for auxiliary power

71. To meet the requirement of auxiliary power, it is proposed to install 6.6 kV/380-220 volt, load-centre sub-stations. From the load-centre sub-station boards, power will be carried to individual power consumers over sub-distribution boards and motor control centres located at appropriate load-centres.

Cost of power

72. The annual cost of electricity, calculated on the basis of a flat rate of US $ 0.013 per kWh, is estimated at $ 400,300.

Water supply system

73. The existing water supply system is a centralised recirculating system with make-up water drawn from the Nile. The estimated water requirement is as follows:

		m^3/hr
Water in circulation	..	500
Make-up water	..	30

74. It is gathered that about 500 cu m/hr of water in circulation will be available from the existing water system, which would be capable of meeting the water demand. Hence no additional facilities are necessary.

<u>Implementation schedule for adopting OBM process</u>

75. The reconstruction work for adopting the OBM process can be divided into the following three broad areas:

i) additions to the existing steelmelt shop

ii) dismantling works and modifications within the existing steelmelt shop

iii) installation of new facilities and modifications outside the steelmelt shop.

Additions to the existing <u>steelmelt shop</u>

76. The construction of the 170 m long and 22.5 m wide new casting aisle is the most important addition to the Thomas shop. The present lime aisle will be extended by 20 m to the south and the necessary lime storage, grinding and conveying facilities will be installed for the OBM (Q-BOP) converters.

77. The two storied general administration building for the steelmelt shop is located only at a distance of about 26 m to the west of the axis E. The existing small off-set at the north-east corner of the office building is likely to interfere with the proposed addition of the new casting aisle and therefore may need to be removed.

Major dismantling work and modifications within <u>steelmelt shop</u>

78. The major modifications required within the steelmelt shop area are the dismantling and re-erection of the existing crane girders and columns between rows 5 and 8 on the E axis and casting new combined foundations

for the affected columns along axes E and H. The roof girders supporting the mixer roof will be temporarily supported at props during the dismantling of columns and their re-instatement.

79. The 16/3-ton crane traversing the ladle repair aisle and the crane girders have to be dismantled. The two electric furnaces will be dismantled as soon as the new converters are commissioned after regular production runs. The furnace foundations and ladle pits will be filled up to lay a track between rows 16 and 17 for transferring scrap from the scrap yard to the mixer aisle and charging aisle. The trolleys of the 16/3-ton charging crane traversing in this aisle will be dismantled and suitably modified for the magnet attachment after providing DC connection to the magnet. The casting pits for the Thomas steel will be filled up and the track for the steel casting car dismantled. The scrap transfer car will be laid parallel and close to the axis D. The casting pits for the electric arc furnaces will also be filled up.

Re-erection of cranes

80. One 25/5-ton ladle crane and the 10-ton stripper crane from the mixer and casting aisle will be dismantled and re-installed in the new casting aisle. The 3-ton mono-rail is to be dismantled.

Summary and conclusions (cont'd)

Installation of new facilities and modifications outside steelmelt shop

81. The major new auxiliary facility required to be installed outside the boundaries of the reconstructed steelmelt shop is oxygen plant.

82. The existing connections of the railway lines to the steelmelt shop have to be modified to suit the alignment of the new tracks and the shifted locations of the existing spurs.

Construction volume

83. The preliminary estimates of major items of work involved in dismantling and reconstruction for adopting the OBM (Q-BOP) process are given in Table 7.

Table 7

ESTIMATE OF DISMANTLING AND RECONSTRUCTION WORK

Item of work		Dismantling	Reconstruction
Stationary equipment	..	270 tons	-
Overhead cranes and monorails	..	4 Nos.	-
Civil work:			
Precast concrete work	..	-	5 250 sq m
Brick masonry	..	-	1.375 sq m
Brick walls	..	1 040 sq m	-
Glazing	..	4 000 sq m	4 000 sq m
Rail/car tracks	..	25 m	300 m
Reinforced concrete	..	525 cu m	4 875 cu m
Structural steelwork:			
Building structures	..)	150 tons	1 180 tons
Floor plates	..)		65 tons
Overhead cranes	..)		207 tons

Summary and conclusions (cont'd)

Scheduling by critical path method

84. To enable a proper appraisal of the cost implications and for providing guidelines for implementing the selected scheme, the shut-down and reconstruction periods have been ascertained by critical path network. The network for adopting the OBM (Q-BOP) process is presented in Drawing 519-0-3. The total period for engineering as well as the timing and duration of the shut down, derived from this network, are given below:

		Months from 'go ahead' signal
Total engineering and reconstruction period	..	27
Shutdown begins after	..	23
Shutdown duration (total months)		4

These periods are reckoned from the date of the 'go-ahead' signal by HADISOLB after negotiations with the promotors of OBM process, finalisation of financing arrangements for the project and appointment of consulting engineers. It is expected that these arrangements would be finalised by HADISOLB by the end of 1972 and the 'go-ahead' signal is assumed to be given by 1st January 1973.

85. The groups of activities along the critical paths for the overall implementation schedule identified from the network are the construction of the new casting aisle, the erection of equipment in this aisle and preparation of technical specifications, issue of enquiries, placement of orders, delivery and erection of oxygen plant.

Shutdown period

86. Two critical paths are envisaged for shutdown period. The twin activities of the dismantling of the 25/5-ton ladle and 10-ton stripper overhead travelling cranes in the mixer and charging aisle and their re-erection in the casting aisle are critical for determining the shutdown duration. The civil and structural works comprising dismantling of 3 to 4 main columns and 4 to 5 crane girders along the axis E, breaking foundations of these columns, casting new combined foundation for columns E and H axes at the same location and re-erection of dismantled columns and crane girders constitute another parallel critical path for this alternative.

Equipment delivery period

87. Delivery periods for the supply and shipment of major equipment from the date of placement of order are estimated as follows:

	Period of delivery to site from placement of order months	Available float months
OBM facilities	5	12
Oxygen plant	14	Nil
Flux grinding plant	10	5

88. It is expected that the bulk of the imported equipment will be purchased from European suppliers and therefore an allowance of two months for ocean and inland transport from the date of shipment is considered adequate. As adoption of OBM process involves the new steelmaking technique, a six month period for negotiating know-how and equipment supplies is envisaged. It may be worthwhile to note that a large float is available in the placement of order and delivery of OBM facilities as modifications to the existing Thomas converters can only be taken up after work in the new casting aisle is sufficiently advanced when the shutdown operation is undertaken. It would, however, be advisable to carry out negotiations with the OBM equipment supplier at an early stage, as indicated in the network, as this being a new process, would warrant more elaborate scrutiny.

Adjustments for lead and lag periods

89. Appropriate adjustments in the time-estimates for individual activities are provided in the form of lead and lag timings where major successive activities overlap. For example, a lead of three months for fabrication over the erection of structural steelwork has been provided assuming that the erection work can be started three months after the commencement of fabrication. Similarly, a time lag of one month for completion of the erection of structural steelwork beyond completion of its fabrication has been provided. In the case of some major equipment like oxygen plant, a lead of about four months for the receipt of materials at the plant site has been provided.

Construction materials

90. Heavy joists and channels above the depth of 26 cm, crane girder rails of heavy profiles as well as a few other sections of structural steel are not rolled indigenously at present and hence will have to be imported well ahead of the fabrication of structural steelwork. Also, the indent for the requisite sections on the local rolling mills has to be placed well in advance to enable the rolling mills to pool together orders of economic batch sizes. It will,

therefore, be necessary to place bulk indents for structural steel within 5 to 6 months from the 'go ahead' signal in anticipation of the possible requirements of sections on finalisation of building designs.

91. As the steelmelt shop is an intermediate production unit in the integrated steel plant, advance planning would be necessary to minimise disruptions in the operations of other upstream and down stream units when the Thomas converters are shut down for reconstruction. In case of blast furnaces, necessary arrangements for pig casting and sale of pig iron would have to be made. For keeping the existing rolling mills in operation, the supply of required tonnages of ingots, blooms and billets will have to be ensured.

Capital cost estimate for OBM (Q-BOP) process

92. The capital cost estimate of reconstruction of the steelmelt shop for adopting the OBM process is only indicative of the order of magnitude of investment, solely for the purpose of evaluating the relative

Summary and conclusions (cont'd)

economics of this alternative as compared to other possible schemes. The estimate includes:

i) cost of dismantling existing items;

ii) cost of modifications and reconstruction of existing facilities retained;

iii) cost of new facilities within the steel-melt shop and major auxiliary items;

iv) losses arising out of stoppage of production during reconstruction;

v) cost of engineering services;

vi) contingencies; and

vii) interest charges on capital expenses during reconstruction.

Cost of dismantling

93. The 'net cost' estimate of dismantling work after allowing credit for the salvage value of the dismantled items is given in Table 8.

Table 8

NET COST ESTIMATE OF DISMANTLING WORK

		'000 £
Cost of dismantling		
Structural steelwork	..	8
Civil work	..	18
Equipment	..	29
Total cost of dismantling	..	55
Salvage value		
Discarded equipment:		
Re-usable	..	74
Waste scrap value	..	3
Discarded structures	..	7
Total salvage value	..	84
Net cost of dismantling	..	- 29

Cost of modification/ reconstruction of existing facilities

94. The cost of modification and reconstruction of existing facilities have been estimated to include the cost of reconstruction of all structural steel and civil engineering items, relaying of bogie and railway tracks and re-erection of equipment at new locations.

Re-use of dismantled structures

95. It is assumed that dismantled, prestressed concrete roof slabs will not be suitable for re-use. No credits have been allowed for possible re-use of dismantled structures, nor is any provision made for expenses on minor items like new bolts, nuts, splicing materials, etc, necessary for assembling and re-erecting old structures.

96. The estimated costs of reconstruction and modification are given in Table 9.

Table 9

COST ESTIMATE OF RECONSTRUCTION WORK

		'000 $
Reconstruction with steelmelt shop		
Civil work	..	560
Structural steelwork	..	535
Railway tracks	..	13
Re-erection of overhead cranes	..	64
Reconstruction outside steelmelt shop		
Utilities and services	..	196
Railway tracks	..	6
Total cost of reconstruction	..	1,174

Cost of new facilities

97. The estimated cost of supply and erection of new equipment and utilities together with the foreign exchange requirements for the various alternatives is given in Table 10. The estimates are based on prevailing prices of similar equipment in the European market as well as information available with the Consulting Engineers. For estimating the transport charges, customs duty and erection cost, the rates prevalent in Egypt have been taken into consideration.

Table 10

COST OF SUPPLY AND ERECTION OF NEW EQUIPMENT AND UTILITIES

		Total '000 $	Foreign currency '000 $
Steelmaking equipment and accessories	..	175	135
Auxiliary sections	..	452	151
Material handling equipment	..	569	10
Utilities	..	4 663	2 789
Miscellaneous items	..	455	-
Total	..	6 314	3 085

Cost of engineering services

98. A provision of 8 per cent of the estimated cost of supply and erection of new facilities and dismantling and reconstruction works has been made for engineering services and construction supervision.

Summary and conclusions (cont'd)

Shut-down losses

99. The continuing cash expenses during the shut-down period, comprising wages, insurance and overheads, are considered as the financial losses due to shut-down of the Thomas converters and have been included in the capital cost estimate. The continuing cash expenses have been estimated at $ 470,295 per year.

Contingencies

100. Contingencies have been allowed for at 5 per cent of the estimated reconstruction cost, to cover inaccuracies of estimate and minor design refinements during project implementation.

Total capital cost estimate

101. The total capital cost estimate is given in Table 11.

Table 11

TOTAL CAPITAL COST ESTIMATE FOR RECONSTRUCTION

		Total '000 $	Foreign currency '000 $
1. New equipment and utilities:			
i) Supply	..	5 508	3 085
ii) Erection	..	806	-
2. Dismantling	..	-29	-
3. Reconstruction work	..	1 174	140
4. Construction supervision and engineering services	..	597	299
5. Shut-down cost	..	116	-
6. Contingencies	..	409	176
Total	..	8 581	3 700

Summary and conclusions (cont'd)

Phasing of expenditure

102. The total capital expenditure is expected to be phased out in five half-year periods. The pattern of phasing is given below:

Half-year period from 'go-ahead' signal		Capital expenditure '000 $
1	..	840
2	..	960
3	..	4 124
4	..	2 104
5	..	596
Total	..	8 624

Interest on capital during reconstruction

103. Based on the phasing of capital expenditure shown above, interest charges have been calculated at 6.5 per cent per annum. It is assumed that all funds will be available at the beginning of the relevant period. The total interest charges so computed total $ 551,000.

Progressive replacement of retained equipment

104. In addition, periodic replacement costs will have to be incurred at the end of the economic life of the existing equipment which will be retained after reconstruction. The estimated annual capital cost of such replacement from the year 1975 onwards has been assumed at the rate of 2 per cent of the

Summary and conclusions (cont'd)

replacement value of the retained equipment. The effect of this has been taken into account in the financial evaluation.

Operating cost estimates

Manpower requirements

105. The present strength of the steelmelt shop is about 1,070. Based on the prevailing manning pattern, the estimated manpower requirement is given in Table 12.

Table 12

ESTIMATED MANPOWER REQUIREMENT

Personnel		Number required
Management and administration	..	20
Technicians and supervisory staff	..	113
Skilled workers ..	..	283
Semi-skilled workers ..	..	355
Clerical and office staff	..	18
Total ..	..	789

Annual wage bill

106. The annual labour cost, calculated on the basis of the average current wages of the employees in the Thomas converter shop, is shown in Table 13.

Table 13

ESTIMATED ANNUAL LABOUR COST

Total men on pay roll ..	..	789
Total annual cost ('000 $)	..	564
Average manpower cost/ton of ingot ($)		1.49

Summary and conclusions (cont'd)

Material cost

107. Operating costs include all costs associated with the conversion of raw materials into ingots and have been estimated under two heads, namely 'materials cost' and 'cost above materials'. The materials cost has been estimated on the basis of unit costs of materials and utilities and the materials consumption for the process required. Credit has been allowed in the estimates for by-products, such as short and rejected ingots and ladle skull.

Cost above materials

108. 'Cost above materials' covers all other items of expenditure incurred in processing the raw materials, namely labour and supervision, power, fuel and water, refractories, supplies and lubricants, repairs and maintenance and general plant expenses. The cost estimates have been based on the prevailing costs at the Helwan steel plant.

Annual operating cost

109. The estimated operating cost per ton of ingot and the annual operating expenses are given in Table 14.

Table 14

UNIT AND ANNUAL OPERATING COSTS

		Per ton of ingot $	Annual expenses '000 $
Cost of materials	..	60.44	22 967
Cost above materials	..	19.03	7 231
Total	..	79.47	30 198

Summary and conclusions (cont'd)

Production during transition

110. Taking into account the effects of the shut-down of the Thomas converter operations and the gestation periods, the steel output that can be expected during the transition period, till the reconstructed steelmelt shop reaches its new rated capacity, is given in Table 15.

Table 15

ANTICIPATED PRODUCTION DURING TRANSITION PERIOD[a]

Year from 'go-ahead'	Steelmaking equipment	Utilisation of rated capacity %	Production '000 tons
Second	Converter	100	183.3[b]
	Electric fce	100	50.0
			233.3
Third	Converter	60	171.0[c]
	Electric fce	100	12.5[d]
			183.5
Fourth	Converter	90	342.0
Fifth	Converter	100	380.0

a/ Production during first year will continue to be at the present level of 250,000 tons.
b/ Production for the first 11 months only and shut-down in the twelfth month.
c/ Production during the last 9 months.
d/ Production for the first 3 months.

Annual operating cost during transition

111. In estimating the annual operating cost during the transition period, only the operating expenses pertaining to the production from the reconstructed

facilities, from the time they are commissioned till they reach their rated capacities, have been taken into account. However, the operating expenses on electric arc furnaces for the period they are kept in operation during the third year have been included in the estimate. The costs of labour and supervision and repair and maintenance expenses would remain constant, while other expenses would generally vary with the capacity utilisation. The annual operating expenses during the transition period computed on this basis have been taken into account in the financial evaluation.

FINANCIAL EVALUATION

Basis of evaluation

112. The profitability of a project is usually evaluated on the basis of expected sales realisation. In the present case, however, fixing of a sales price for steel ingot for working out the profitability would be a notional exercise of limited value, as ingot is only an intermediate product. It is, therefore, necessary to adopt a more suitable method to evaluate the impact of the additional fixed investment estimated.

Method adopted

113. The method adopted for financial evaluation in the present context is to work out (i) the savings in the operating costs effected by reconstruction compared to the current operating cost with the existing facilities and (ii) the benefits resulting from increased production capacity arising out of the additional investment. The total annual value of these savings and benefits is treated as return on the additional investment estimated.

114. As the current operating cost of HADISOLB is based on the use of hot metal produced from Aswan ore, it needs to be revised on the basis of using Bahariya ore in the existing steelmelt shop facilities to make it comparable with the operating cost estimate

for OBM process where hot metal produced from Bahariya ore will be refined. During 1970/71, the combined average cost of ingot steel made from Thomas converters and electric furnaces was about $ 139 per ton excluding fixed charges. Assuming a level of production of 200,000 tons of Thomas steel and 50,000 tons of electric furnace steel from the existing facilities, the combined average cost is estimated at $ 92.65 per ton of ingot, if hot metal produced from Bahariya ore with necessary rephosphorisation were refined in the Thomas converters.

115. The financial evaluation has been made on the following criteria of profitability:

i) total annual cost and average cost per ingot ton including incidence of fixed charges on the additional investment;

ii) present worth of capital and operating outlays per ingot ton;

iii) internal rate of return on the additional investment; and

iv) pay-back period of the additional investment calculated on discounted basis.

<u>Total annual cost and cost per ton</u>

Annual costs and costs per ton

116. The annual operating cost for the present level of operation using Bahariya ore instead of Aswan ore is estimated at $ 23.16 million, which would give an

estimated cost of $ 92.65 per ingot ton, compared to the present average cost of $ 139 per ton for steel produced from electric furnace and Thomas converters. The total annual operating cost has been estimated on the basis of cost of materials and cost above materials. Fixed charges have been computed only for the additional facilities prepared for reconstruction. Depreciation charges on equipment and buildings as well as replacement items have been calculated at 5 per cent per annum. The fixed expenses during construction have been amortised at 5 per cent per annum. Interest on working capital is computed at 8 per cent and on long-term borrowings at 6.5 per cent. Working capital requirements have been estimated at 3 months' operating expenses.

117. Taking the average annual OBM steel production in a normal year at the full rated capacity of 580,000 tons per year, the estimates of annual and unit operating expenses and fixed charges are given in Table 16.

Table 16

UNIT AND ANNUAL COSTS INCLUDING FIXED CHARGES

		Unit cost $/ton	Annual cost '000 $
Operating cost			
Cost of material	..	60.44	22 967
Cost above materials	..	19.03	7 231
Total operating cost	..	79.47	30 198
Fixed charges			
Depreciation	..	1.14	434
Amortisation	..	0.17	66
Interest on working capital		1.59	604
Interest on long-term loans		1.71	650
Total fixed charges	..	4.61	1 754
Total production cost	..	84.08	31 952

Present worth analysis

118. For the purpose of calculating the present worth of the capital and operating outlays, a discount rate of 7 per cent per annum has been assumed. The output figures are also similarly discounted. The present worth calculations for the OBM facilities as well as for the existing facilities, are summarised in Table 17.

Table 17

PRESENT WORTH CALCULATIONS
(Discount rate - 7 per cent)

		Unit	Alt. 4 OBM process	Current
Discounted present value of:				
Capital outlays	..	'000 $	9 901	-
Operating outlays	..	'000 $	303 467	245 378
Total outlays	..	'000 $	313 368	245 378
Output	..	'000 t	3 809	2 649
Unit production - Discounted outlays/ discounted output	..	$/t	82.27	92.65

119. For working out the internal rate of return, all cash outflows by way of fixed investment and all cash inflows representing savings in operating expenses and benefits of additional output have been discounted. The estimated internal rate of return of 25 per cent is obtained with OBM process.

Payback period

120. The payback period has been computed by compounding all capital expenses during reconstruction at 7 per cent per annum up to the zero point and discounting all savings in operating expenses and annual capital expenditure at the same rate below the zero point. On this discounted basis, the payback period is estimated at 4 years.

Results of financial evaluation

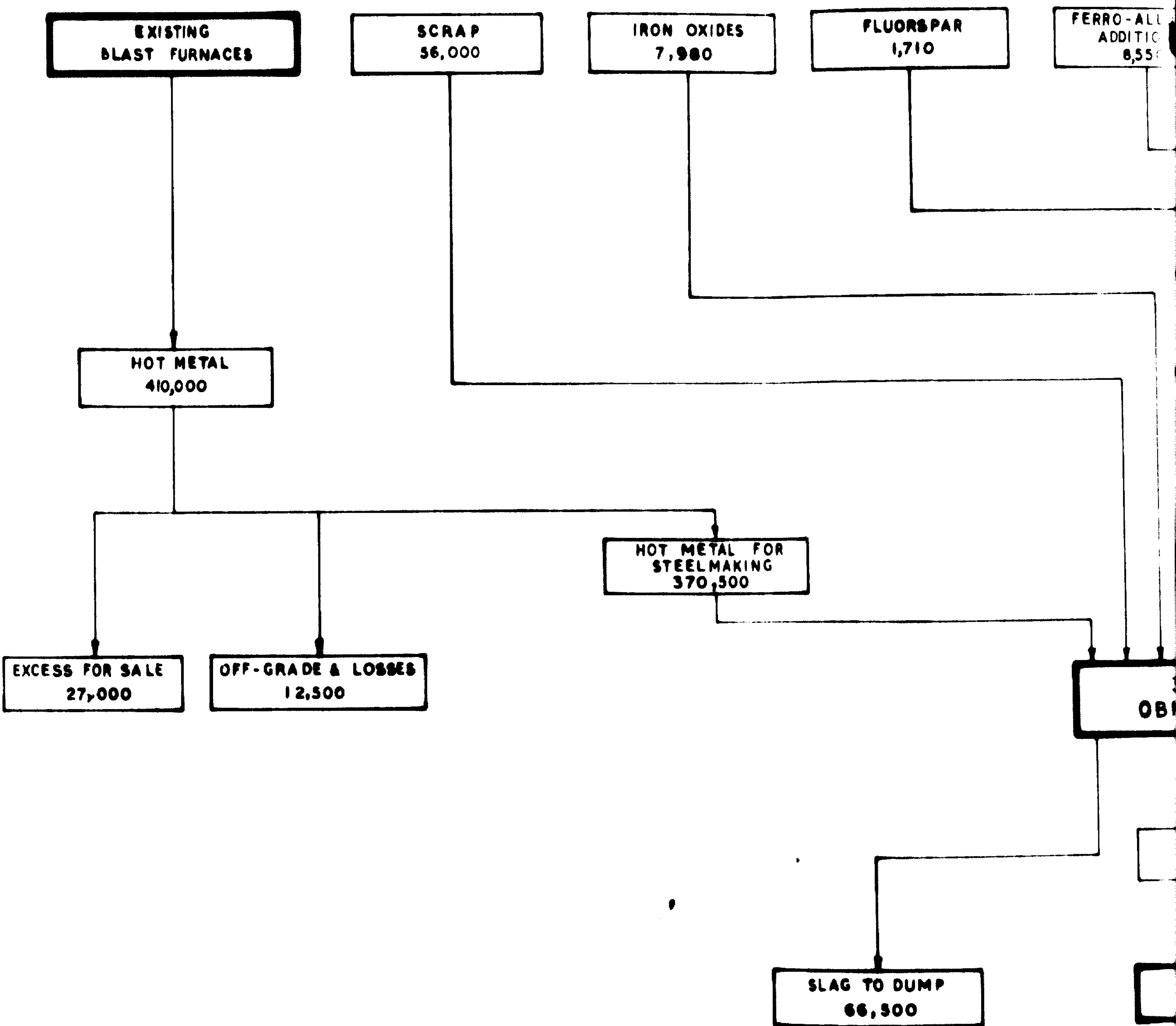
121. The results of the financial evaluation for switch-over to OBM process are summarised in Table 18.

Table 18

RESULTS OF FINANCIAL EVALUATION

Fixed investment a/	..	$ 8.62 million
Unit cost at rated capacity including fixed charges, per ingot ton	..	$ 84.08
Present worth of capital and operating outlays, ingot ton	..	$ 82.27
Internal rate of return	..	25 per cent
Payback period	..	4 years

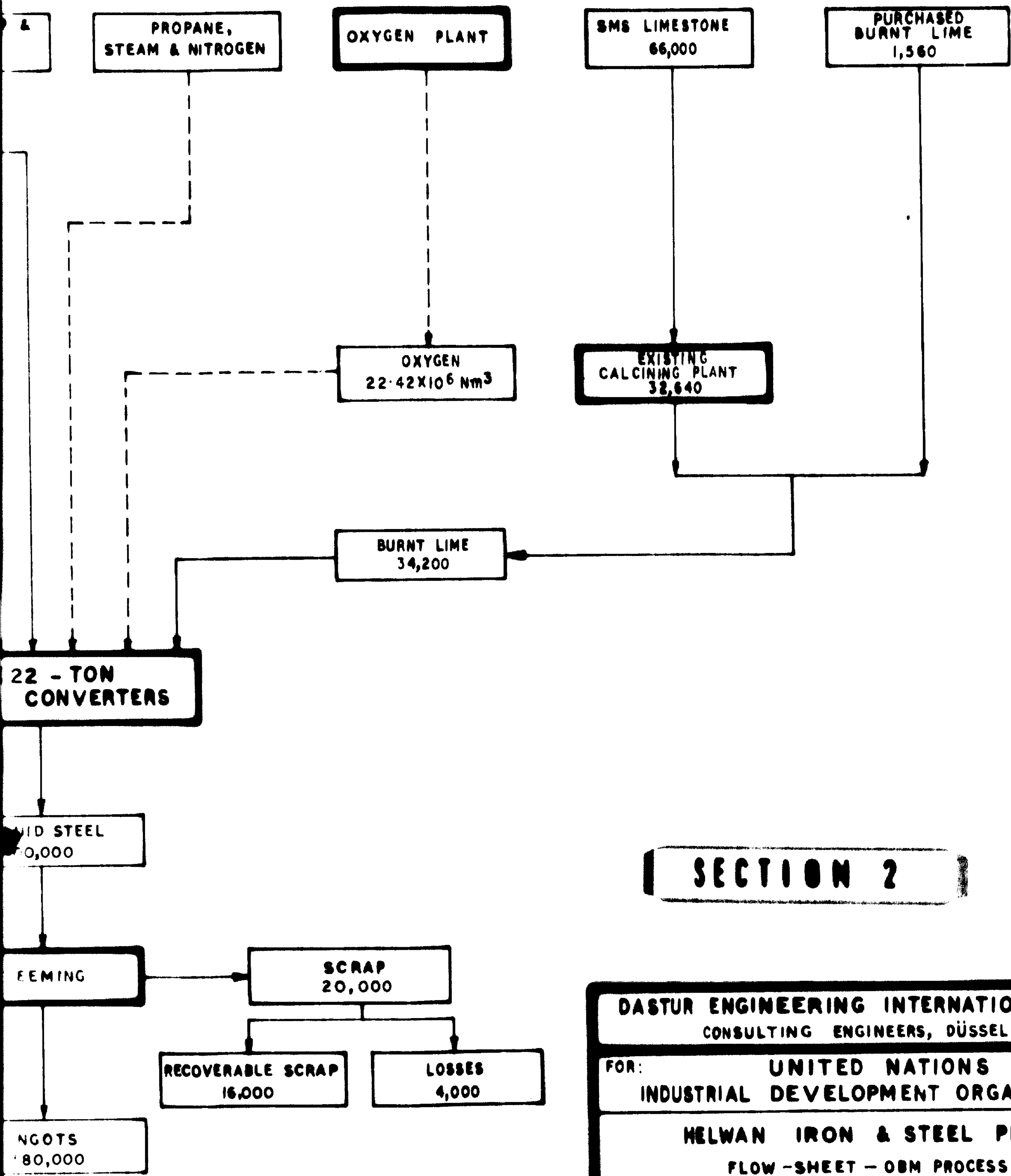
a/ Excluding capitalised interest charges during construction.



SECTION 1

NOTE:

QUANTITIES IN TONS PER YEAR UNLESS OTHERWISE SPECIFIED



DASTUR ENGINEERING INTERNATIONAL GmbH
CONSULTING ENGINEERS, DÜSSELDORF

FOR: UNITED NATIONS
INDUSTRIAL DEVELOPMENT ORGANIZATION

HELWAN IRON & STEEL PLANT
FLOW-SHEET – OBM PROCESS

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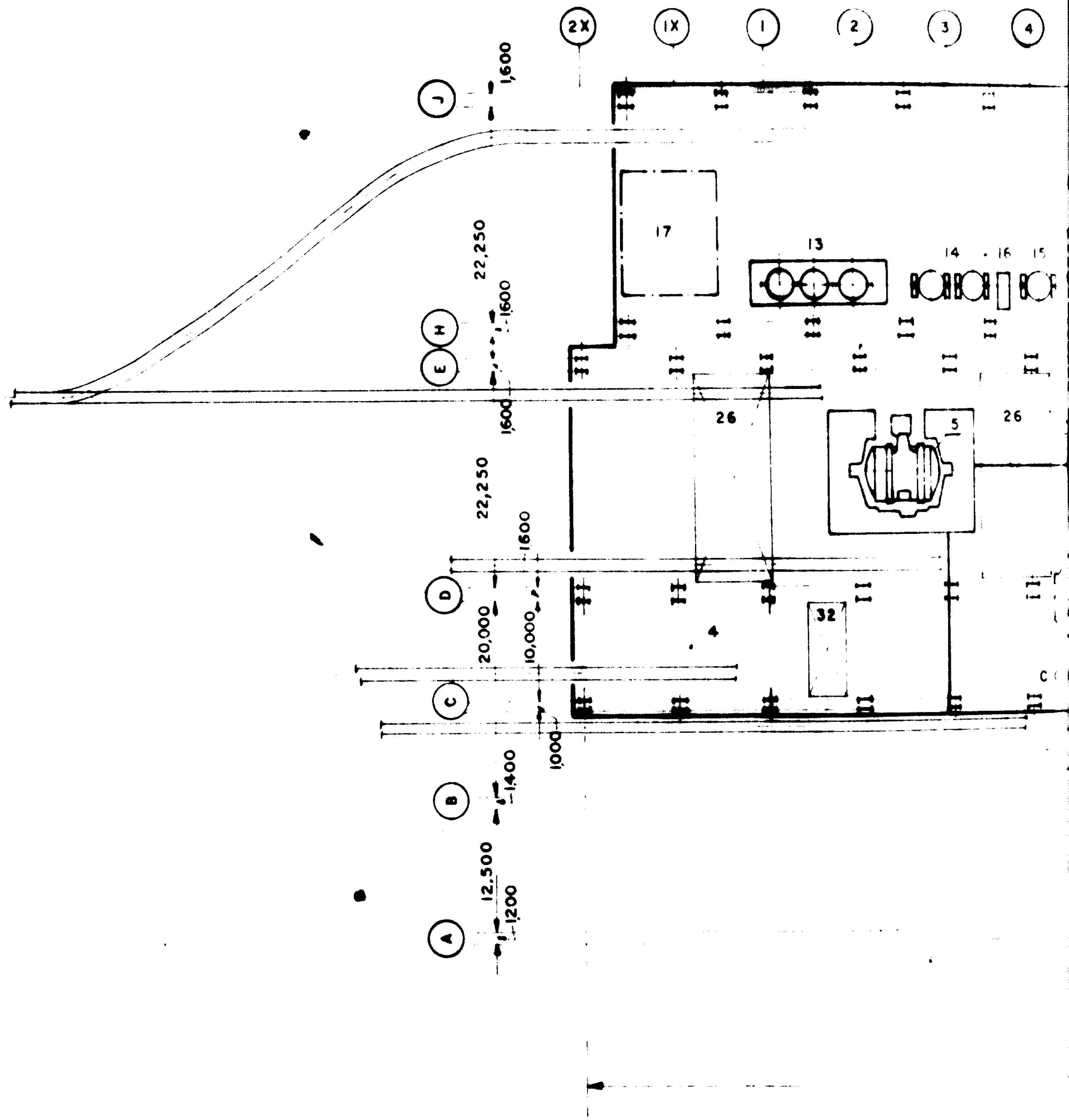
APPROVED	[signature]	5.6.72	



2X
1X
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4
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H
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D
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B
A
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1600
1600
22,250
1600
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1,000
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17
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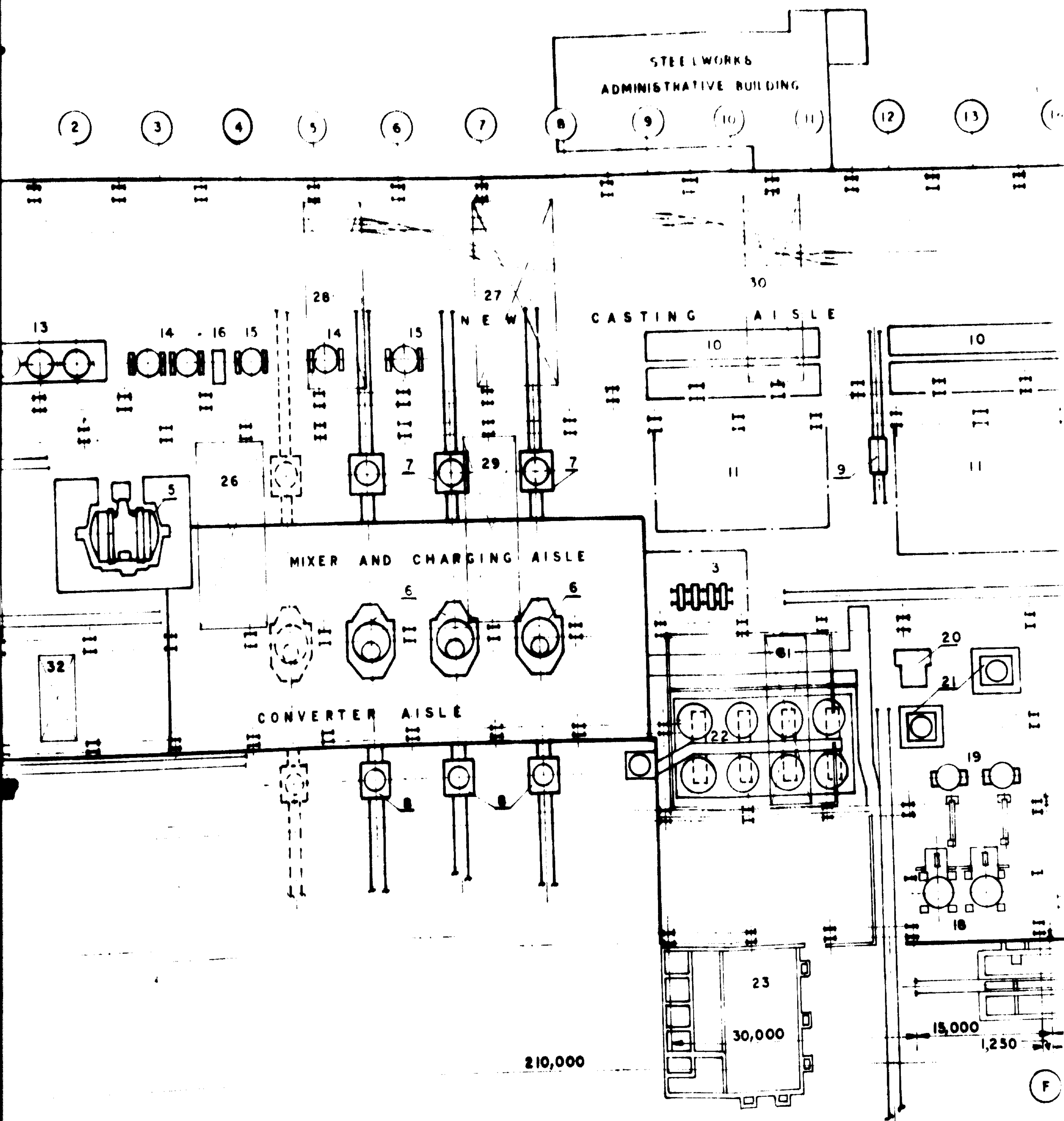
SECTION 1


STEELWORKS
ADMINISTRATIVE BUILDING
2
3
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28
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NEW CASTING AISLE
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16
15
14
15
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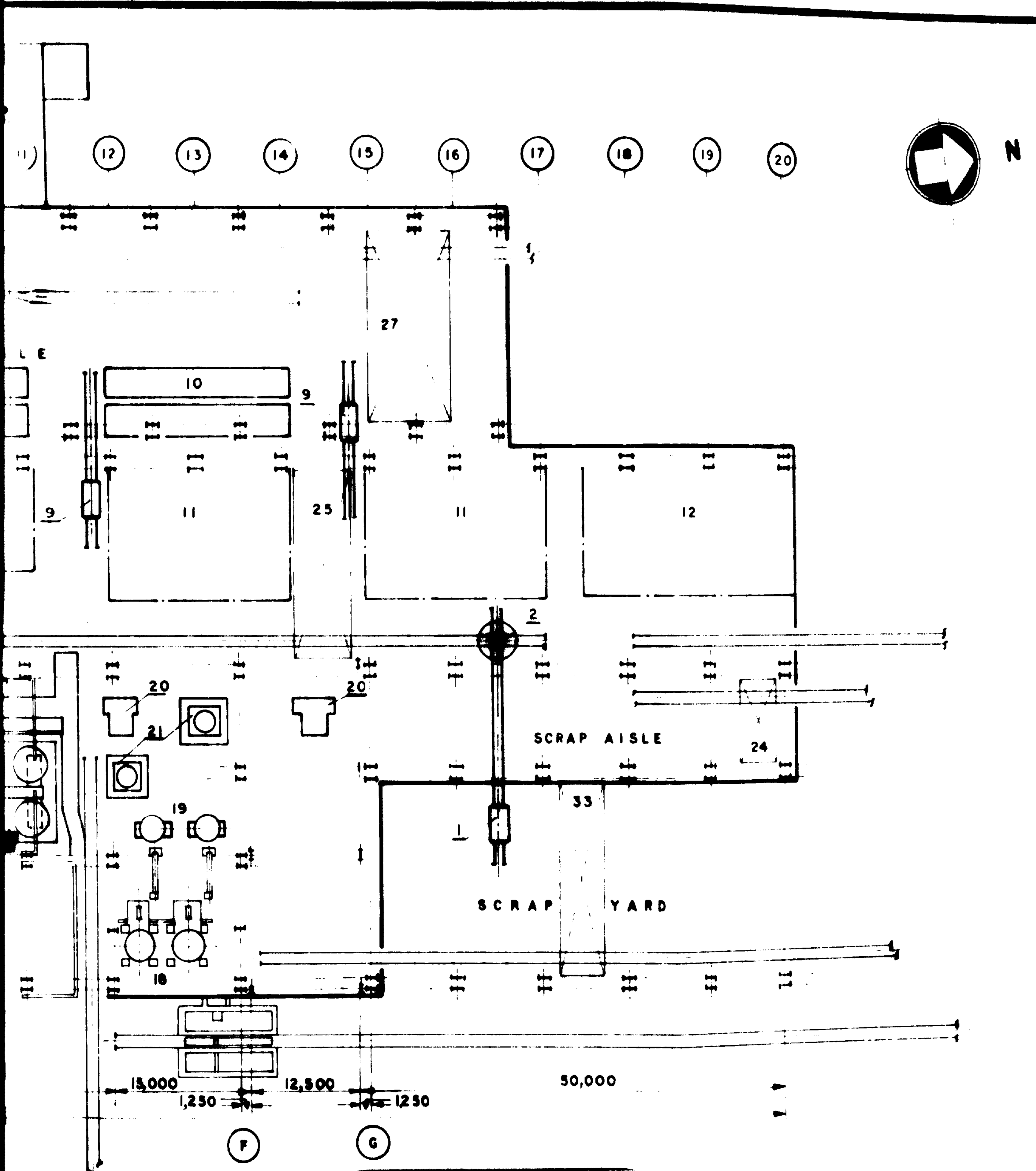
10
26
7
29
7
5
11
9
11
MIXER AND CHARGING AISLE
6
6
3
32
CONVERTER AISLE
20
21
22
19
8
8
18
23
30,000
210,000
15,000
1,250
F

SECTION 2



12
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21
SCRAP AISLE
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19
33
1
SCRAP
YARD
18
15,000
12,500
50,000
1,250
1,250
F
G

SECTION 3

LEGEND

1 SCRAP TRANSFER CAR
2 TURN TABLE
3 SCRAP BOX STORAGE AREA
4 FLUX GRINDING PLANT
5 800^T HOT METAL MIXER
6 22^T OBM CONVERTER
7 STEEL TRANSFER CAR
8 SLAG POT CAR
9 MOULD TRANSFER
10 INGOT CASTING AREA
11 MOULD COOLING & CLEANING AREA
12 STORAGE FOR NEW MOULDS
13 LADLE RELINING PIT
14 LADLE HEATING
15 LADLE STAND
16 STOPPER ROD OVEN
17 LADLE DESKULLING AREA
18 DOLOMITE SHAFT KILN
19 PAN MILL
20 BRICK PRESS
21 CONVERTER BOTTOM RAMMING MACHINE
22 CONVERTER BOTTOM BURNING OVEN
23 ELECTRIC SWITCH HOUSE
24 $16/3^T$ MAGNET CRANE (EXISTING CRANE MODIFIED)
25 10^T MOULD HANDLING CRANE
26 $80/10^T$ HOT METAL CHARGING CRANE
27 $50/10^T$ CASTING CRANE
28 $25/5^T$ LADLE CRANE (RELOCATED)
29 $25/5^T$ SCRAP CHARGING CRANE
30 STRIPPER CRANE (RELOCATED)
31 $12{\cdot}5^T$ OVERHEAD TRAVELLING CRANE
32 3^T CRANE FOR FLUX GRINDING PLANT
33 8^T MAGNET CRANE

ADDITIONAL FACILITIES

N

10 5 0 10 20 30 40

SCALE: METRES

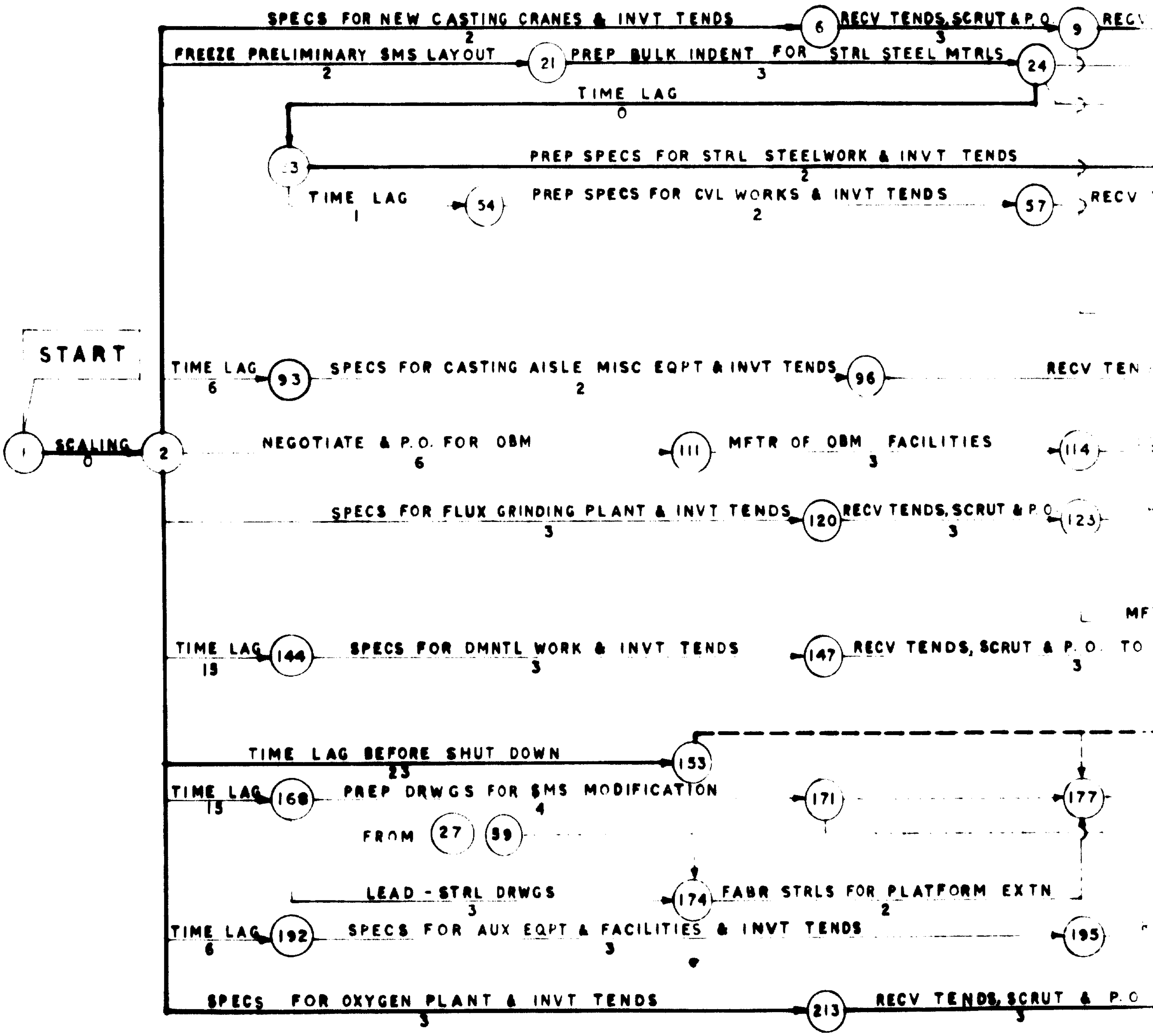
DASTUR ENGINEERING INTERNATIONAL GmbH
CONSULTING ENGINEERS, DÜSSELDORF

FOR:
UNITED NATIONS
INDUSTRIAL DEVELOPMENT ORGANIZATION

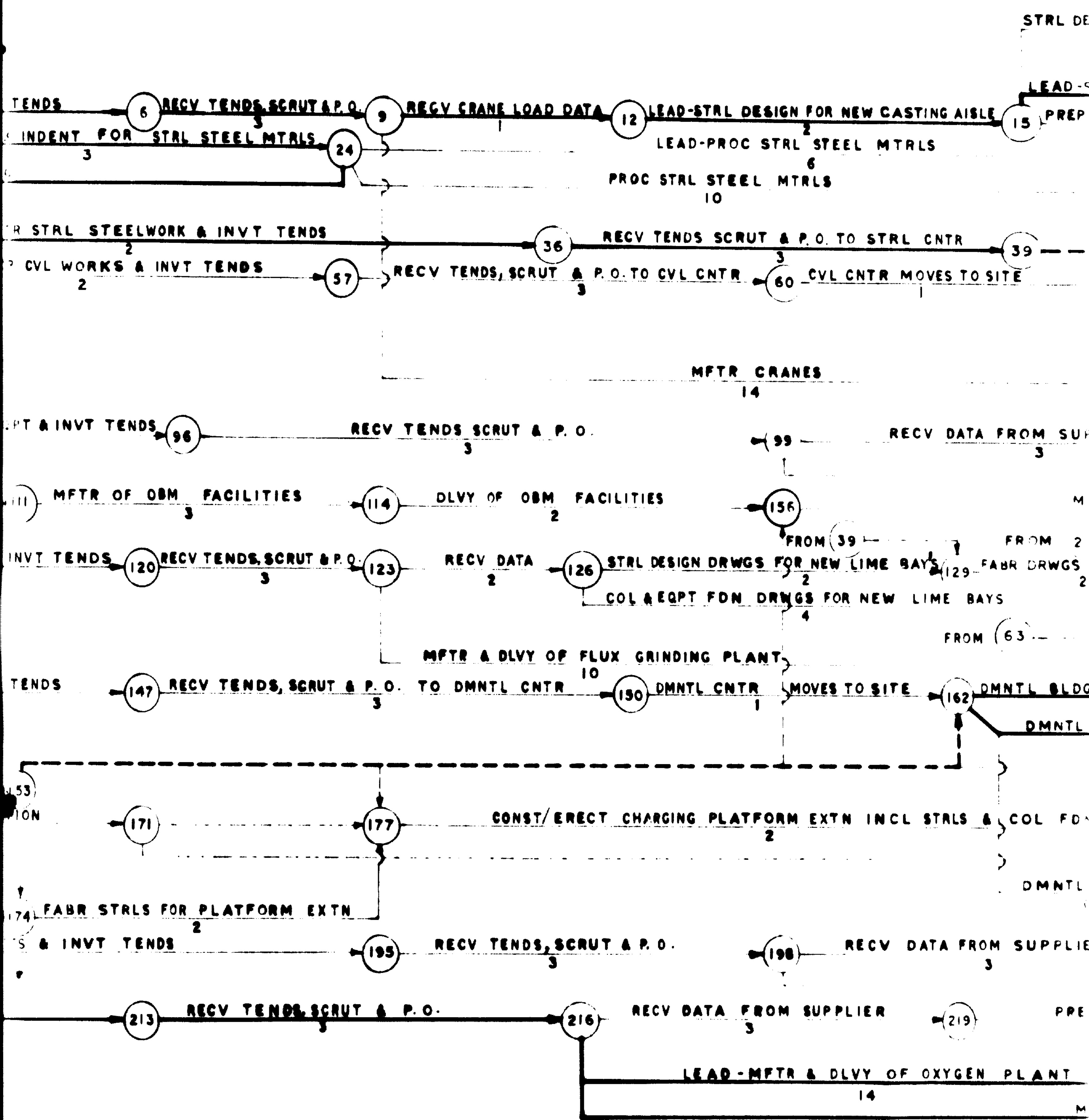
HELWAN IRON & STEEL PLANT
STEELMELT SHOP – MODIFICATIONS FOR OBM PROCESS

DRAWN		.5.72	No. 519-0-2
APPROVED		15.5.72	

SECTION 4


START
SCALING
0
SPECS FOR NEW CASTING CRANES & INVT TENDS
2
RECV TENDS, SCRUT & P.O.
3
FREEZE PRELIMINARY SMS LAYOUT
2
PREP BULK INDENT FOR STRL STEEL MTRLS
3
TIME LAG
0
PREP SPECS FOR STRL STEELWORK & INVT TENDS
2
TIME LAG
1
PREP SPECS FOR CVL WORKS & INVT TENDS
2
RECV
TIME LAG
6
SPECS FOR CASTING AISLE MISC EQPT & INVT TENDS
2
RECV TEN
NEGOTIATE & P.O. FOR OBM
6
MFTR OF OBM FACILITIES
3
SPECS FOR FLUX GRINDING PLANT & INVT TENDS
3
RECV TENDS, SCRUT & P.O.
3
MF
TIME LAG
15
SPECS FOR DMNTL WORK & INVT TENDS
3
RECV TENDS, SCRUT & P.O. TO
3
TIME LAG BEFORE SHUT DOWN
23
TIME LAG
15
PREP DRWGS FOR SMS MODIFICATION
4
FROM 27 59
LEAD - STRL DRWGS
3
FABR STRLS FOR PLATFORM EXTN
2
TIME LAG
6
SPECS FOR AUX EQPT & FACILITIES & INVT TENDS
3
SPECS FOR OXYGEN PLANT & INVT TENDS
3
RECV TENDS, SCRUT & P.O.
3

SECTION 1


STRL DE
LEAD-S
TENDS
6
RECV TENDS, SCRUT & P.O.
3
9
RECV CRANE LOAD DATA
1
12
LEAD-STRL DESIGN FOR NEW CASTING AISLE
2
15
PREP
INDENT FOR STRL STEEL MTRLS
3
24
LEAD-PROC STRL STEEL MTRLS
6
PROC STRL STEEL MTRLS
10
R STRL STEELWORK & INVT TENDS
2
36
RECV TENDS SCRUT & P.O. TO STRL CNTR
3
39
CVL WORKS & INVT TENDS
2
57
RECV TENDS, SCRUT & P.O. TO CVL CNTR
3
60
CVL CNTR MOVES TO SITE
1
MFTR CRANES
14
PT & INVT TENDS
96
RECV TENDS SCRUT & P.O.
3
99
RECV DATA FROM SU
3
111
MFTR OF OBM FACILITIES
3
114
DLVY OF OBM FACILITIES
2
156
M
FROM 39
FROM 2
INVT TENDS
120
RECV TENDS, SCRUT & P.O.
3
123
RECV DATA
2
126
STRL DESIGN DRWGS FOR NEW LIME BAYS
2
129
FABR DRWGS
2
COL & EQPT FDN DRWGS FOR NEW LIME BAYS
4
FROM 63
MFTR & DLVY OF FLUX GRINDING PLANT
10
TENDS
147
RECV TENDS, SCRUT & P.O. TO DMNTL CNTR
3
150
DMNTL CNTR MOVES TO SITE
1
162
DMNTL BLDG
DMNTL
153
ION
171
177
CONST/ERECT CHARGING PLATFORM EXTN INCL STRLS & COL FD
2
DMNTL
174
FABR STRLS FOR PLATFORM EXTN
2
S & INVT TENDS
195
RECV TENDS, SCRUT & P.O.
3
198
RECV DATA FROM SUPPLIE
3
213
RECV TENDS, SCRUT & P.O.
3
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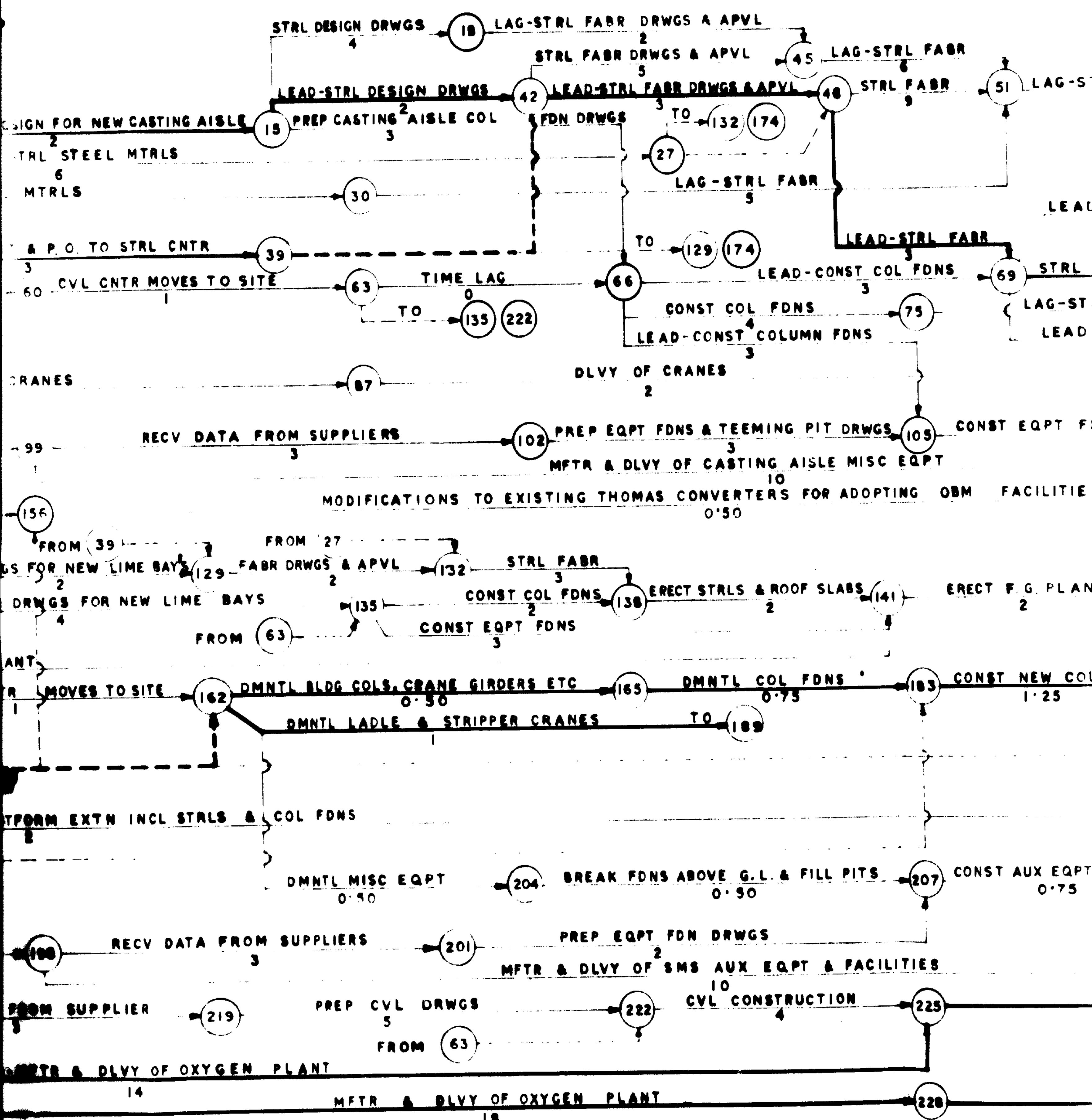
RECV DATA FROM SUPPLIER
3
219
PRE
LEAD-MFTR & DLVY OF OXYGEN PLANT
14
M

SECTION 2


STRL DESIGN DRWGS
4
18
LAG-STRL FABR DRWGS & APVL
2
STRL FABR DRWGS & APVL
5
45
LAG-STRL FABR
6
LEAD-STRL DESIGN DRWGS
2
42
LEAD-STRL FABR DRWGS & APVL
3
48
STRL FABR
9
51
DESIGN FOR NEW CASTING AISLE
2
15
PREP CASTING AISLE COL
3
FDN DRWGS
TO
132
174
STRL STEEL MTRLS
6
27
MTRLS
30
LAG-STRL FABR
5
& P.O. TO STRL CNTR
3
39
TO
129
174
LEAD-STRL FABR
3
CVL CNTR MOVES TO SITE
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60
63
TIME LAG
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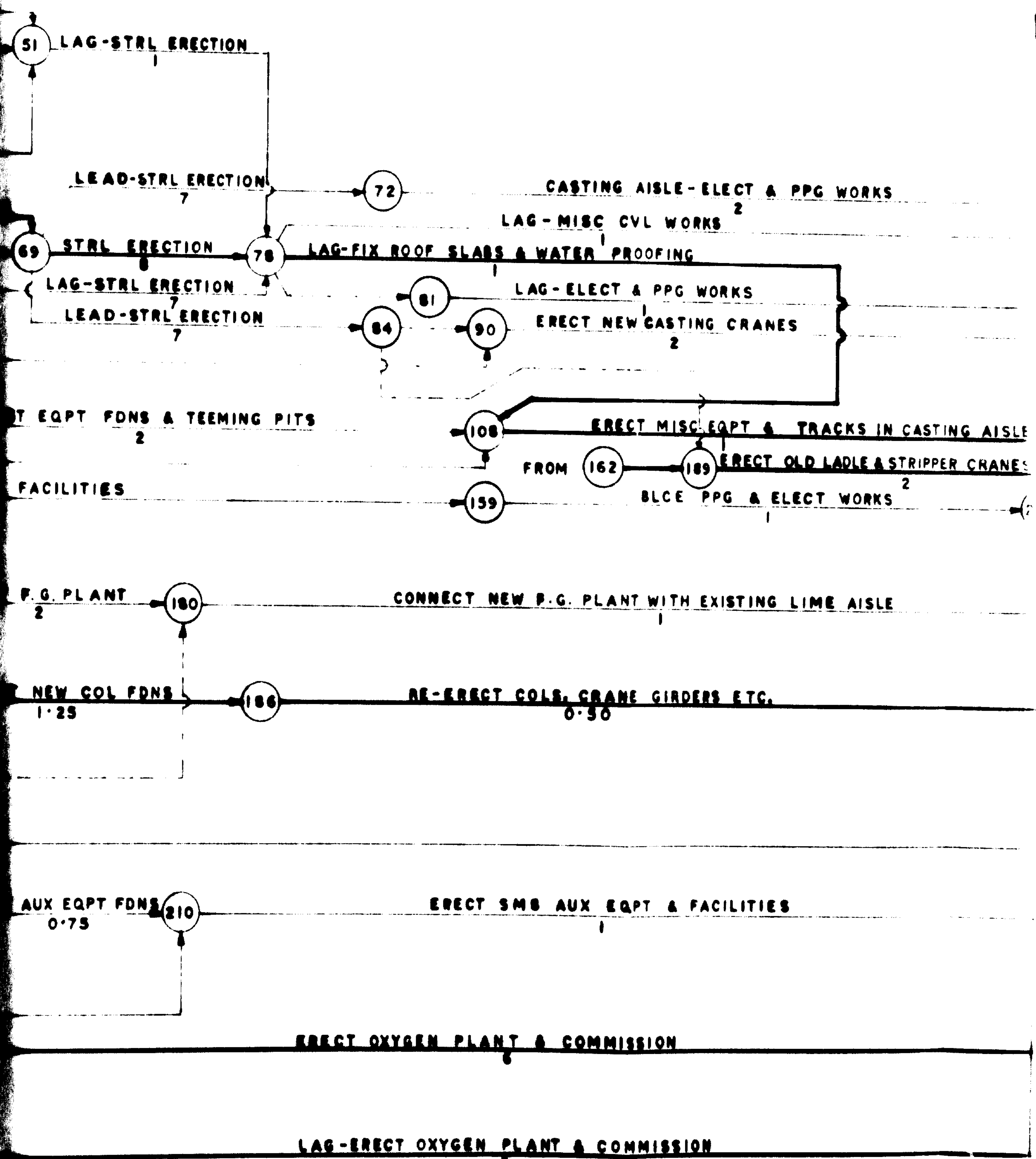
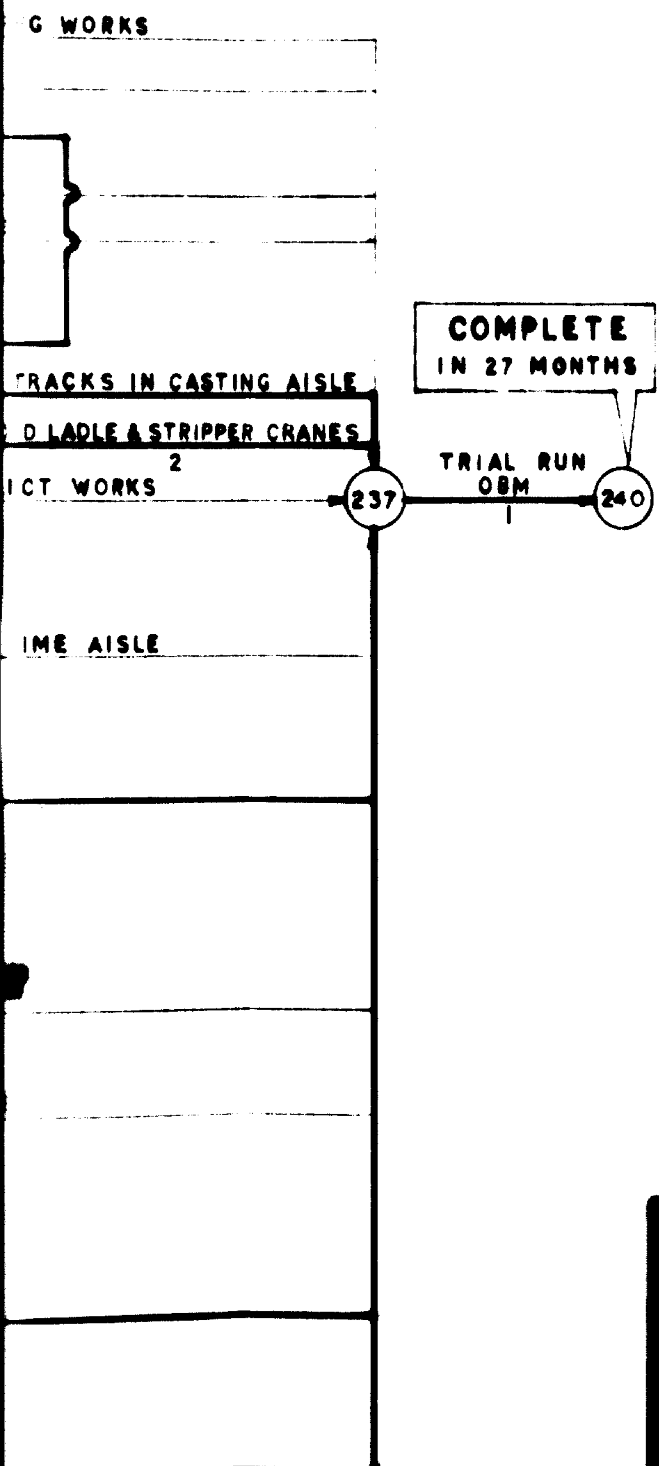
66
LEAD-CONST COL FDNS
3
69
STRL
TO
135
222
CONST COL FDNS
4
75
LAG-ST
LEAD-CONST COLUMN FDNS
3
LEAD
CRANES
87
DLVY OF CRANES
2
RECV DATA FROM SUPPLIERS
3
99
102
PREP EQPT FDNS & TEEMING PIT DRWGS
3
105
CONST EQPT F
MFTR & DLVY OF CASTING AISLE MISC EQPT
10
MODIFICATIONS TO EXISTING THOMAS CONVERTERS FOR ADOPTING OBM FACILITIE
0·50
156
FROM 39
FROM 27
GS FOR NEW LIME BAYS
2
129
FABR DRWGS & APVL
2
132
STRL FABR
3
DRWGS FOR NEW LIME BAYS
4
135
CONST COL FDNS
2
138
ERECT STRLS & ROOF SLABS
2
141
ERECT F.G. PLAN
2
FROM 63
CONST EQPT FDNS
3
ANT
MOVES TO SITE
1
162
DMNTL BLDG COLS, CRANE GIRDERS ETC
0·50
165
DMNTL COL FDNS
0·75
183
CONST NEW COL
1·25
DMNTL LADLE & STRIPPER CRANES
1
TO
189
TFORM EXTN INCL STRLS & COL FDNS
2
DMNTL MISC EQPT
0·50
204
BREAK FDNS ABOVE G.L. & FILL PITS
0·50
207
CONST AUX EQPT
0·75
198
RECV DATA FROM SUPPLIERS
3
201
PREP EQPT FDN DRWGS
2
MFTR & DLVY OF SMS AUX EQPT & FACILITIES
10
FROM SUPPLIER
219
PREP CVL DRWGS
5
222
CVL CONSTRUCTION
4
225
FROM 63
MFTR & DLVY OF OXYGEN PLANT
14
MFTR & DLVY OF OXYGEN PLANT
18
228

SECTION 3



51
LAG-STRL ERECTION
1
LEAD-STRL ERECTION
7
72
CASTING AISLE-ELECT & PPG WORKS
2
LAG-MISC CVL WORKS
1
69
STRL ERECTION
78
LAG-FIX ROOF SLABS & WATER PROOFING
1
LAG-STRL ERECTION
7
81
LAG-ELECT & PPG WORKS
1
LEAD-STRL ERECTION
7
84
90
ERECT NEW CASTING CRANES
2
T EQPT FDNS & TEEMING PITS
2
108
ERECT MISC EQPT & TRACKS IN CASTING AISLE
1
FROM
162
189
ERECT OLD LADLE & STRIPPER CRANES
2
FACILITIES
159
BLCE PPG & ELECT WORKS
1
F.G. PLANT
2
180
CONNECT NEW F.G. PLANT WITH EXISTING LIME AISLE
1
NEW COL FDNS
1·25
186
RE-ERECT COLS, CRANE GIRDERS ETC.
0·50
AUX EQPT FDNS
0·75
210
ERECT SMS AUX EQPT & FACILITIES
1
ERECT OXYGEN PLANT & COMMISSION
6
LAG-ERECT OXYGEN PLANT & COMMISSION
2

SECTION 4



NOTES:

1. ACTIVITY DURATIONS IN MONTHS.
2. CRITICAL PATH SHOWN IN RED.
3. FOLLOWING ABBREVIATIONS HAVE BEEN USED IN ACTIVITY DESCRIPTIONS:

APVL	=	APPROVAL
AUX	=	AUXILIARY
BLCE	=	BALANCE
BLDG	=	BUILDING
CNTR	=	CONTRACTOR
COL	=	COLUMN
CONST	=	CONSTRUCT
CVL	=	CIVIL
DLVY	=	DELIVERY
DMNTL	=	DISMANTLE
DRWG	=	DRAWING
ELECT	=	ELECTRICAL
EQPT	=	EQUIPMENT
EXTN	=	EXTENSION
FABR	=	FABRICATE / FABRICATION
FDN	=	FOUNDATION
F. G.	=	FLUX GRINDING
G. L.	=	GROUND LEVEL
INCL	=	INCLUDING
INVT	=	INVITE
MFTR	=	MANUFACTURE
MISC	=	MISCELLANEOUS
MTRL	=	MATERIAL
P.O.	=	PLACE ORDER
PREL	=	PRELIMINARY
PREP	=	PREPARE
PROC	=	PROCURE
RECV	=	RECEIVE
SCRUT	=	SCRUTINISE
SMS	=	STEELMELT SHOP
SPECS	=	SPECIFICATIONS
STRL	=	STRUCTURAL
TEND	=	TENDER

SECTION 5

DASTUR ENGINEERING INTERNATIONAL GmbH
CONSULTING ENGINEERS, DÜSSELDORF

FOR: UNITED NATIONS
INDUSTRIAL DEVELOPMENT ORGANIZATION

HELWAN IRON & STEEL PLANT
CRITICAL PATH NETWORK – MODIFICATION TO OBM PROCESS

DRAWN	[signature]	8/6/72	No. 519-0-3
APPROVED	[signature]	12.6.72	

1 - INTRODUCTION

The Egyptain Iron and Steel Company

The Egyptian Iron and Steel Company (HADISOLB) was incorporated in 1954 and the construction of the integrated steel plant commenced in 1956. The plant is located on the right bank of the river Nile near Helwan, about 30 km south of Cairo. The original facilities were designed and engineered by M/s Demag of West Germany. The various units were progressively commissioned from 1958 onwards and by June 1960, all the units were in operation. Today, this is the only integrated steel plant in the Arab Republic of Egypt (ARE).

Following the adoption of the socialist programme and the nationalisation of heavy industries, the Egyptian General Organisation for the Metallurgical Industries (EGOMI) was created in 1961 with the object of planning and co-ordinating the metallurgical activities in the country. HADISOLB is one of the nine metallurgical units functioning under EGOMI.

1 - Introduction (cont'd)

The crude steel production at the Helwan steel plant during recent years has averaged 245,000 tons, the highest achieved so far being 255,971 tons in 1968/69. To meet the increasing demand for steel, HADISOLB is currently implementing an expansion programme with Soviet assistance, which would raise the capacity to 1.5 million tons of crude steel per year. Of this, 1.2 million tons are planned to be achieved from the expansion facilities.

<u>Existing facilities</u>

The existing plant occupies an area of 275 hectares and has a railway network of about 40 km and a road system of 17 km. The basic production units installed originally included two 5.1 m hearth dia blast furnaces, three 17-ton Thomas convertors and two 12-ton electric arc furnaces. As coke ovens were not provided initially, blast furnace coke was being imported from Europe. The rolling mill complex comprised one 900 mm blooming and slabbing mill, one 3-stand 750 mm medium section mill, one 1,800 mm wide 3-high plate mill and a 1,250 mm wide 2-high sheet mill.

<u>Initial production units</u>

Subsequently, one 550 mm light section mill from the Delta Steel Plant was shifted and installed at Helwan in 1964. During the same year, a battery of 50 coke ovens

<u>Additional facilities</u>

1 - Introduction (cont'd)

was built which is now using coal imported from the Soviet Union. The coke plant is not a part of HADISOLB and is located adjacent to the steelworks. A sintering machine of 50 sq m sintering area was also installed in 1964. As the actual ingot steel production fell considerably short of the original rated capacity of 265,000 tons per year, a fourth 17-ton Thomas converter was added in March 1967. In the same year, the construction of a 1,200 mm semi-continuous hot strip mill and two 1,200 mm reversible 4-high cold rolling mills was started and the units went into production in 1969, using slabs imported from the Soviet Union.

Use of high-phosphorus Aswan ore

The blast furnaces have been operating with high-phosphorus iron ore transported by rail from the mines near Aswan over a distance of 950 km. Limestone is brought by rail from the quarries at Refaii, over a distance of 25 km. Coal is imported through the Alexandria port and transported by rail over a distance of 150 km to the steel plant. The high-phosphorus hot metal is refined in the Thomas converters. Steel is made in the electric arc furnaces by melting scrap.

1 - Introduction (cont'd)

Annual steel production

The annual production of hot metal, ingot steel and saleable rolled products from 1967/68 to 1970/71 is shown in Table 1-1.

Table 1-1

ANNUAL PRODUCTION (1967/68 TO 1970/71)

Year	Hot metal tons	Steel ingots Thomas tons	Steel ingots Electric tons	Rolled products incl blooms and billets for sale tons
1967/68	264 339	198 280	48 801	198 409
1968/69	272 206	205 573	50 398	204 936
1969/70	259 684	197 186	46 555	203 216
1970/71	256 623	191 194	42 740	174 945

Expansion programme

Rated capacity

The new steel complex under the expansion programme is being built adjoining the existing facilities. The expansion will be implemented in two stages, 0.6 million tons of crude steel capacity in the first stage, rising to 1.2 million tons at full development. The first stage facilities are expected to be commissioned by June 1973 and the full development completed by June 1975. The total area within fence, including the existing plant, will be about 505 hectares. The plant flow sheet at full development as envisaged in the expansion project is shown in Drawing 519-1-1.

1 - Introduction (cont'd)

New production facilities

The major production facilities to be installed in the first stage are one 1,033 cu m blast furnace, two 75 sq m sintering machines, two 80-ton LD converters (one operating), two 2-strand slab casting machines and one 6-strand billet casting machine. At full development, additionally, one blast furnace, two sintering machines, one LD converter, one slab casting machine and two billet casting machines of identical sizes will be installed. The entire steel production of the new complex will be continuously cast into slabs and billets.

Switch-over to low-phosphorus Bahariya ore

Iron production in the expansion scheme is based on the use of low-phosphorus iron ore from the El-Gedida deposits in the oasis of Bahariya, situated 300 km south-west of the steel plant. The two existing blast furnaces will also switch over to Bahariya ore after expansion.

According to the expansion scheme, the total annual production of hot metal will be 1.75 million tons including 410,000 tons from the two existing blast furnaces. Of this, about 1.2 million tons would be consumed in the new LD shop and about 248,000 tons offered for sale, leaving 300,000 tons for conversion into steel in the existing Thomas shop.

1 - Introduction (cont'd)

However, during discussions with HADISOLB, the Consulting Engineers were advised that the Thomas shop when reconstructed should be capable of producing 330,000 tons of ingot steel per year, excluding the production from the electric arc furnaces, and that no scrap would be available for the Thomas shop. It was further indicated that, for the purpose of this study, the existing plant may be considered independent of the new complex and hence all requirements of ore, lime, dolomite, scrap etc needed for the reconstructed Thomas shop be taken care of by providing necessary additional facilities.

Objectives of the study

HADISOLB envisages that only low-phosphorus Bahariya ore will be used for ironmaking after expansion. The low-phosphorus iron that would be produced with this ore in the existing blast furnaces would not be suitable for conversion into steel by the Thomas process. It is, therefore, necessary to study the technological ways and means for reconstructing the Thomas converter shop to enable the use of low-phosphorus hot metal and at the same time to increase the ingot steel production to 330,000 tons per year. The aim of this study is to provide the Government

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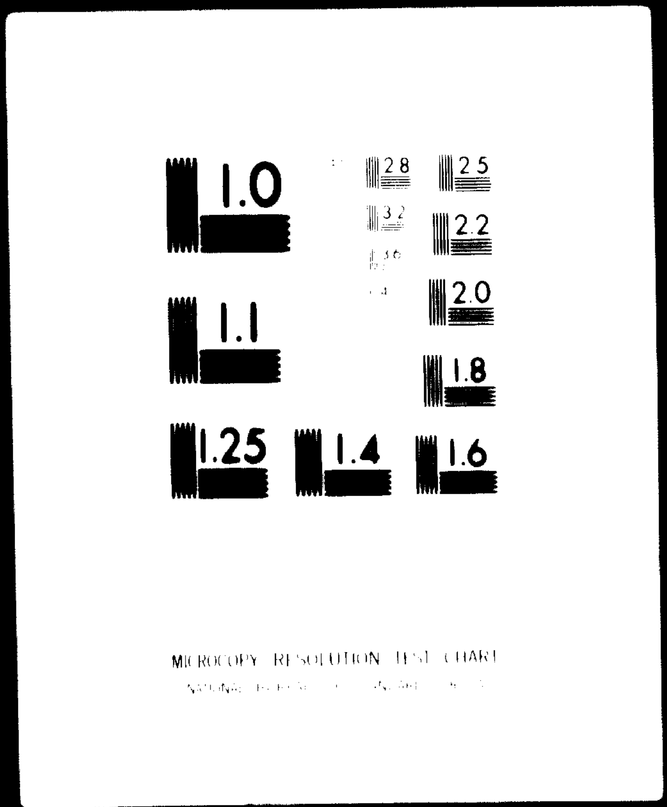

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1 - Introduction (cont'd)

of the Arab Republic of Egypt with basic information and technical data on possible utilisation of the existing Thomas steelmelt shop when the projected switch-over is made from Aswan ore to Bahariya ore.

Authorisation

This study has been carried out at the instance of the United Nations Industrial Development Organization (UNIDO) in accordance with Contract No. 71/64 (Project No. SIS 70/1125) dated 18th October 1971, subsequently modified by Amendment 1 dated 18th November 1971, Amendment 2 dated 18th January 1972 and letter TP/MM/jml dated 21st March 1972. Relevant extracts from the original scope of work from the Contract and the subsequent amendments are given in Appendix 1-1.

Scope of work

The final scope of work is outlined below:

1. Examine from the technical and economic view-points of the various possible alternatives for the modifications of the steelmelting shop including:

   a) the reconstruction of the steelworks and the replacement of the Thomas converters by LD converters;

1 - Introduction (cont'd)

b) the modifications of the existing Thomas converter in order to raise the capacity from 17 tons/heat to 20-25 tons/heat;

c) any acceptable alternative proposal appropriate as a solution.

2. Study and evaluate other promising alternatives for modifications of the steelmelting shop and further:

a) determine and recommend after critical examinations the best techno-economic alternative;

b) estimate the capital and operating cost for the recommended alternative; and

c) suggest a tentative plan of implementation for this alternative to serve as a basis for further action by the Egyptian Organisation for Metallurgical Industries.

Structure of the report

The report is presented in nine chapters supported by necessary tables, appendices and drawings. Following this introductory chapter, the existing Thomas converter shop facilities and the performance are reviewed. The next chapter outlines the alternative schemes for the reconstruction of the Thomas converter shop. The additional facilities and modifications required for the alternative schemes are elaborated. The service and utility requirements have also

1 - Introduction (cont'd)

been discussed. The various aspects of plant reconstruction are considered and network charts indicating the preliminary construction schedule developed. Capital cost estimates for the alternative schemes are presented, followed by estimates of manpower requirements and operating costs. Finally, a techno-economic evaluation has been made of the alternative schemes and the most suitable scheme recommended.

Field study

In connection with this study, the Consulting Engineers deputed their experts to the Helwan steel plant for an on-the-spot study of the current operations of the Thomas converter shop and the existing facilities and to collect the relevant data. The names of the experts and the duration of their stay at Cairo are given in Appendix 1-2.

A series of discussions were held by the team with the Chairman of EGOMI, the Acting General Manager of EGOMI, and the Chairman and officers of HADISOLB. A list of persons and organisations contacted in connection with this study is given in Appendix 1-3.

Acknowledgement

The Consulting Engineers gratefully acknowledge the co-operation and assistance extended by the UNDP officials at Cairo, EGOMI and HADISOLB in the preparation of this

1 - Introduction (cont'd)

report. Particularly, they wish to thank the Chairman and the Works General Manager of the Steel Company for making all arrangements and giving facilities for the field study team. The Consulting Engineers would also like to express their thanks specifically to Mr Alfons Ghattas Gobrial and Dr Essat Maarouf who, from HADISOLB's side, were closely associated with the day-to-day programme of the team in connection with the visits to the various departments of the steel plant, discussion with the plant personnel and collection of data.

2 - STEELMELT SHOP FACILITIES AND PERFORMANCE

Steelmelt shop capacity

Initial facilities and capacity

The existing steelmelt shop at the Helwan steel plant consists of the Thomas converter section and the electric arc furnace section. The facilities were commissioned in 1958, with an annual rated capacity of 265,000 tons of steel ingots, comprising 229,000 tons of Thomas steel and 36,000 tons of electric furnace steel. The production units installed initially were three 17-ton converters and two 12-ton arc furnaces. A list of the major equipment and facilities originally provided is given in Appendix 2-1.

Shortfall in output

However, as the actual production from the Thomas converters was considerably lower than the rated capacity, certain ancillary facilities were added from time to time to improve the output. Despite these efforts, the maximum production achieved till 1965/66 from the Thomas converters was only 158,640 tons in 1962/63. The output from the arc furnaces, however, exceeded the rated capacity during the same period and reached 41,977 tons in 1965/66.

Additional facilities

In order to step up the Thomas steel production, a fourth converter of identical capacity was installed in March 1967. During the subsequent years, some balancing facilities such as overhead cranes, bottom-baking ovens, jack car, ladles etc were added. The additional facilities are listed in Appendix 2-2.

Past production

Production achieved

The ingot steel production from 1959 to 1970/71 is shown in Table 2-1. With the commissioning of the fourth converter, there was a marked increase in the production. The highest production achieved so far from the Thomas converters has been 205,573 tons in 1968/69. During the same year, the electric furnaces also registered a record output of 50,398 tons.

Table 2-1

INGOT STEEL PRODUCTION

Year a/		Thomas converters tons	Elec.arc furnaces tons	Total tons
1959	..	92 821	19 185	112 006
1960	..	111 784	24 385	136 169
1961	..	128 617	27 552	156 169
1962 (Jan-June)		70 394	8 056	78 450
1962/63	..	158 640	34 471	193 111
1963/64	..	154 824	38 757	193 581
1964/65	..	148 171	41 539	189 710
1965/66	..	142 794	41 977	184 771
1966/67	..	164 188	45 022	209 210
1967/68	..	198 280	48 801	247 081
1968/69	..	205 573	50 398	255 971
1969/70	..	197 186	46 555	243 741
1970/71	..	191 194	42 740	233 934

a/ Calendar year till 1961 and fiscal year (July to June) from 1962/63 onwards.

2 - Steelmelt shop facilities and performance (cont'd)

Layout and facilities

The layout and cross sections of the existing steelmelt shop building are shown in Drawings 519-2-1 to 519-2-4. The building is laid south to north and comprises three main aisles, namely the mixer and casting aisle, the converter aisle and the electric furnace aisle. Besides, there are several smaller aisles for ladle preparation, bottom making, dolomite plant, blower plant and lime handling, as well as a scrap yard. The major dimensions of the various aisles are given in Table 2-2.

Table 2-2

AISLES IN STEELMELT SHOP BUILDING

Aisles		Length m	Width m	Crane rail height above floor level m
Mixer and casting aisle	..	210	22.25	15.30
Converter aisle	..	60	11	-
Electric furnace aisle	..	50	10	10
Scrap yard	..	50	22.5	10
Ladle preparation aisle	..	45	12.5	10
Bottom preparation aisle	..	45	20	10
Dolomite aisle	..	15	15	-
Blower plant aisle	..	30	12.5	10
Lime handling aisle	..	20	10	13.766

The lime burning plant is installed near the blast furnaces. The slag yard and slag grinding facilities are located away from the meltshop building.

2 - Steelmelt shop facilities and performance (cont'd)

Mixer and casting aisle

The mixer and casting aisle occupies the western side of the steelmelt shop building. A 500-ton hot metal mixer, fired with blast furnace gas and fuel oil, is located at the southern end. This end was extended by 20 m and a new 50/10-ton mixer crane installed in 1971. The new crane and the existing crane of similar capacity ensure uninterrupted operation of the mixer. Hot metal from the blast furnaces is received in 35-ton ladles on rail-bound cars weighed on a track scale outside the Thomas shop. One of the two mixer cranes hoists the ladle and charges the metal into the mixer.

Next to the mixer cranes is the 25/5-ton converter charging crane, which is normally used for charging hot metal into the converter, but the 50/10-ton crane can also be used for this purpose, if required. Four mixer ladles of 20-ton capacity each are provided for drawing the hot metal from the mixer. The mixer ladle is weighed on a 25-ton platform scale located below the mixer pouring-out spout.

In the northern half of the aisle, the casting, stripping and mould storage and preparation facilities are located. The area in between these facilities and the mixer is directly in front of the converters and is used for dumping the casting aisle slag pots. The slag cakes are loaded on to road dumpers.

2 - Steelmelt shop facilities and performance (cont'd)

In the casting area, three pits are provided for Thomas heats which are transported by a rail-mounted casting car running adjacent to these pits. The electric furnace heats are handled by a 25/5-ton overhead crane installed at the northern end of the building, where separate casting pits are available. To the west of the casting pits, along the middle of the aisle, runs a rail track which is used for despatching the hot ingots in box type cars to the soaking pits, and for other miscellaneous purposes such as receiving ingot moulds, bottom plates etc. The area to the west of the track is used for mould storage and mould preparation. Next to the mixer crane is a 10-ton mould handling crane followed by a 10-ton stripper crane.

Converter aisle

The converter aisle houses the four 17-ton Thomas converters which are equipped with hydraulic tilting drives. Above the converters, requisite lime bins and chutes are provided. Two 3-ton trolleys running on a monorail deliver the lime to the converter bins and also to the scrap yard for the electric furnaces. Each converter has an independent fume stack. Slag tracks are laid below the converters for spotting slag pots and jack car. The converter operating platform is 6 m above the floor level and covers the entire width and length of the aisle. The platform extends into the casting aisle with a removable section in front of each converter.

Electric furnace aisles

The two electric furnaces are located in a narrow aisle (10 m width) running parallel and adjacent to the casting aisle at the northern end of the building. Each furnace has a ladle pit, where the ladle is held by the casting aisle crane during tapping of the heat. The electric furnace aisle is served by a 16/3-ton overhead crane for charging scrap and other miscellaneous use.

Scrap yard

The scrap yard is located to the east of and adjacent to the electric furnace aisle and is served by an 8-ton magnet crane. Scrap is delivered in railway wagons. It is loaded into drop-bottom baskets, transferred on a car to the electric furnace aisle and weighed on a 30-ton track scale.

Ladle preparation aisle

The ladle preparation aisle is located across the southern end of the scrap yard and electric furnace aisle. The facilities consist of a stopper rod drying oven, two ladle relining pits, four ladle heaters. The scrap yard track extends into this aisle at the eastern end. Ladle skulls and debris are loaded on to wagons placed on this track. A total of eight steel ladles are available.

2 - Steelmelt shop facilities and performance (cont'd)

Originally, the capacity of these ladles was 15 tons each, which has now been raised to 16.5 tons by increasing the height by 24 cm.

Bottom making aisle

The converter bottom preparation aisle is laid parallel and adjacent to the mixer and casting aisle, to the south of the ladle preparation aisle. The facilities include two pan mills, two bottom ramming machines, a brick press and eight bottom baking ovens, fired with blast furnace gas. This aisle is served by a 12.5-ton overhead crane.

Dolomite plant

Adjacent and to the east of the bottom preparation aisle are located two dolomite shaft kilns which produce about 45 tons of burnt dolomite per day. Raw dolomite is received in rail wagons, unloaded manually and stocked in a nearby area. Its size is reduced to 80 mm - 140 mm in a crusher. The crushed material is delivered in rail-bound trolleys and dumped into the skip pit of the dolomite kilns. Two ground bins, one each for dolomite and coke, are provided. The kilns are charged by bucket elevators. The calcined material is crushed and screened into various fractions and stored in different bins. After weighing and batching, the dolomite is fed by a worm conveyor into the pan mill where about 7 per cent to 10 per cent of tar is added and the mix prepared.

2 - Steelmelt shop facilities and performance (cont'd)

Blower plant

To the south of the dolomite kilns is located the blower plant. Air blast for the converter operation is supplied by two motor-driven blowers, each rated at 55,000 cu m per hour at a discharge pressure of 3.5 atm abs. One of the blowers serves as standby. The hydraulic system for tilting the converters includes two electrically-driven, high-pressure centrifugal pumps designed for a delivery head of 60 atm. The blower plant is served by a 20-ton overhead crane.

Lime handling facilities

The lime handling aisle is located in continuation of the converter aisle at its south end. The lime burning plant is located near the blast furnaces and has two shaft kilns producing about 100 tons of burnt lime per day. The lime is loaded in wagons and delivered to the lime handling aisle. Purchased lime is brought by road in trucks. The lime is unloaded manually into boxes lifted by a 3-ton overhead crane and emptied into four overhead bins. From the bins, the lime is drawn into 1.5 cu m buckets which are lifted by the monorail trolley and transferred to the converter bins and the electric furnace scrap yard.

Slag yard

The converter slag is received in slag pots carried on rail cars and hauled by a locomotive to the slag yard. The slag yard is served by two cranes of 16/8-ton and 10-ton capacities. The slag pots are handled by the 16/8-ton crane and the slag cakes allowed to cool and then dumped. The cakes are broken into small pieces by a steel ball dropped by the overhead crane and are loaded into a bin by a grab bucket. From the bins, the slag is conveyed over a magnetic drum to separate the metallics and then transferred to a crushing, screening and bagging plant for sale as fertilizer. The layout of the slag yard is shown in Drawing 519-2-5.

Steelmaking practice

Raw materials

The major raw materials required for the Thomas converters is hot metal and requisite flux and additive such as burnt lime and ferro-alloys. For the arc furnaces, scrap is used as the melting stock. Other raw materials used in arc furnaces include mill scale, burnt lime, fluorspar and ferro-alloys. The annual raw material consumption in the steelmelt shop for the year 1970/71 is given in Table 2-3. The typical analyses of various raw materials are given in Appendix 2-3.

Table 2-3

ANNUAL MAJOR RAW MATERIAL CONSUMPTION IN STEELMELT SHOP - 1970/71

Raw Materials		Thomas shop tons	Elec. furnace tons	Total tons
Hot metal	..	241 927	-	241 927
Scrap	..	1	47 663	47 664
Mill scale	..	-	1 616	1 616
Burnt lime	..	38 797	1 534	40 331
Fluorspar	..	13	89	102
Ferro-alloys	..	4 271	379	4 650

2 - Steelmelt shop facilities and performance (cont'd)

Hot metal handling

The hot metal received from the blast furnaces has considerable amount of slag which forms practically a solid crust on the top of the metal in the ladle. Before pouring into the mixer, as much of the slag as possible is raked out manually. Thorough deslagging is not possible and considerable amount of hot metal is lost while deslagging. There is also some additional loss of iron, as the blast furnace ladle cannot be completely emptied into the mixer due to the limited lift of the crane hoist.

Hot metal quality

In order to ensure good operating conditions, the quality of the hot metal that is preferred is as follows:

		Per cent
Si	..	0.5-0.6
Mn	..	0.8-1.2
P	..	1.8-2.2
S	..	0.05 max

The temperature of the hot metal should be about 1,300°C. In actual practice, there is considerable swing in the iron chemistry which has an adverse effect on the converter operation. The temperature of the hot metal at the mixer is also lower, around 1,200°C. Approximately 40 per cent of the iron taken out of the mixer has to be desulphurised with soda ash when the sulphur content is over 0.07 per cent.

Converter operation

The converter is brought to the upright position and the required amount of lime is charged from the overhead bins. It is then tilted for receiving hot metal. Normally, the charge contains approximately 18 tons of hot metal. No scrap is used. Blowing is started by turning on the full blast and the converter brought back to the upright position. The blow lasts for about 14 minutes to 16 minutes depending upon the analyses of the hot metal. This includes about 2 minutes to 4 minutes of after-blow. The converter is then turned down, the air blast stopped and the slag removed. The deslagging operation takes about 5 minutes when the steel and slag samples are also taken. Additions such as Fe-Si and Fe-Mn are shovelled into the bath and the heat tapped. A typical heat cycle is given in Table 2-4.

Table 2-4

CHARGE-TO-TAP TIME

Particulars		Time in minutes
Lime and hot metal charging	..	7
Preparation for blowing	..	2
Blowing (including after-blow)	..	15
Deslagging	..	6
Converter additions	..	3
Tapping	..	3
Slag dumping	..	2
Charge-to-tap time	..	38

2 - Steelmelt shop facilities and performance (cont'd)

The heat is received in a teeming ladle held by an electrically-driven casting car, capable of rotating and vertical motions. The car travels to the casting pit and positions the ladle over the ingot moulds. The steel is top-poured into small-end-up moulds. The actual casting time is about 16 minutes. After casting, the overhead crane in the ladle aisle hoists the ladle for dumping the slag and delivering the ladle to the preparation area. A typical operating cycle of the casting car is given in Table 2-5.

Table 2-5

OPERATING CYCLE OF THE CASTING CAR

		Time in minutes
Waiting for tapping	..	5
Tapping	..	3
Travel to casting pit	..	1
Preparation for casting	..	1
Casting	..	16
Changing of ladle	..	8
Travel to converter	..	1
Total cycle time	..	35

The slag made in the Thomas converter is around 250 kg per ton of ingot and the slag analyses are as follows:

2 - Steelmelt shop facilities and performance (cont'd)

		Per cent
SiO_2	..	4 to 8
FeO	..	12 to 17
Fe_2O_3	..	4 to 8
Al_2O_3	..	1 to 2.5
CaO	..	45 to 50
MgO	..	1.5 to 3
P_2O_5	..	17 to 26
MnO	..	3 to 4

Electric furnace practice

Both the electric furnaces are of fixed roof and movable shell type. Scrap loaded in drop-bottom buckets is top charged into the furnace by the overhead crane. The nominal charge weight is about 13 tons per heat. Heat time varies from 3 hours to 3½ hours, a typical cycle being as shown in Table 2-6. The heat is generally bottom-poured into slab ingots.

Table 2-6

ARC FURNACE HEAT CYCLE

Operation		Time in minutes
Charging	..	5
Melting	..	100
Refining	..	60
Tapping	..	5
Fettling	..	20
Total tap-to-tap time		190

Steel grades and casting practice

Steel grades

The bulk of the steel produced in the Thomas converters is of rimming quality for structural grades. In the electric furnaces, rimming, semi-killed and killed steels are made. Killed steel is used mainly for the production of rails.

2 - Steelmelt shop facilities and performance (cont'd)

Ingots produced from the Thomas converter heats are mostly of low carbon and mild steel grades. The electric furnaces produce about 85 per cent low carbon and mild steels and 15 per cent medium and high carbon steels. The various grades of steel made in the Thomas converters during the year 1970/71 are given in Table 2-7.

Table 2-7

THOMAS CONVERTER PRODUCTION - 1970/71

Steel grades		Production tons
St 37	..	125 884
St 35	..	32 142
St 33	..	23 292
St 42	..	6 149
Rail steel	..	1 306
Others	..	2 421
Total	..	191 194

The various grades of steel made from the electric furnaces during 1970/71 are given in Table 2-8.

Table 2-8

ELECTRIC FURNACE PRODUCTION - 1970/71

Steel grades		Production tons
Rail steel	..	4 016
Fish plate	..	827
Copper steel	..	39
St 60	..	546
St 44	..	962
St 37 (rimmed)	..	5 555
St 42	..	9 326
St 50	..	178
St 37B	..	3 654
St 42B	..	11 509
St 35	..	238
Steel for 'butagas' cylinder		3 806
Others	..	1 882
Total	..	42 740

2 - Steelmelt shop facilities and performance (cont'd)

Ingot sizes

Liquid steel from the Thomas converters is cast into 3.5-ton and 4-ton ingots. Electric furnace heats are cast into slab ingots of 1-ton, 1.5-ton and 2-ton weight. The moulds are stripped by the stripper crane and the ingots are loaded out in box cars for despatch to the soaking pits. The sizes and weights of ingots currently being cast are given in Table 2-9.

Table 2-9

SIZES OF INGOTS

Type of ingot mould		Ingot weight tons	Average size of ingot mm
B10	..	1.0	515 x 228 x 1,160
B15	..	1.5	610 x 250 x 1,260
B20	..	2.0	745 x 300 x 1,260
K35	..	3.5	478 x 478 x 1,740
K40	..	4.0	600 x 600 x 1,900

The average life of the square moulds and slab moulds for the years 1966/67 to 1970/71 are given in Table 2-10.

Table 2-10

LIFE OF INGOT MOULDS

Year		Mould life - Heats				
		Square moulds		Slab moulds		
		K40	K35	B20	B15	B10
1966/67	..	44	58	16	10	21
1967/68	..	36	71	18	20	35
1968/69	..	52	75	25	15	26
1969/70	..	49	62	15	16	20
1970/71	..	45	50	20	22	16

2 - Steelmelt shop facilities and performance (cont'd)

Ingot yield

Thomas steel yield

The yield of Thomas steel in terms of good ingots from the metallic charge is about 80 per cent. The breakdown of the losses is given in Table 2-11.

Table 2-11

LOSS IN THOMAS CONVERTER OPERATION

Particulars	Loss %
Hot metal loss	2.0
Chemical loss	8.0
Iron loss in converter slag ..	2.0
Loss due to spitting during blowing	1.5
Loss during deslagging of converter	1.0
Spillage and pit losses ..	0.5
Skull	1.5
Ingot butts	1.0
Rejected ingots	2.0
Total losses	19.5

Arc furnace yield

The yield of good ingots from the electric arc furnace charge is about 86.5 per cent, the losses being as shown in Table 2-12.

Table 2-12

LOSS IN ARC FURNACE OPERATION

Particulars	Loss %
Chemical loss and loss in slag	9.0
Rejected ingots	1.5
Ingot butts	1.0
Skull	1.5
Spillage and pit loss ..	0.5
Total losses	13.5

2 - Steelmelt shop facilities and performance (cont'd)

Specific consumption of materials

The specific consumption of materials per ton of good ingot for the Thomas converter and electric furnace heats is given in Table 2-13.

Table 2-13

SPECIFIC CONSUMPTION OF MATERIALS

Materials	Thomas converter kg/ton	Arc furnace kg/ton
Hot metal ..	1 230	-
Scrap ..	-	1 125
Mill scale ..	-	30
Ferro-silicon ..	5	2
Ferro-manganese	16	6.7
Aluminium ..	-	0.3
Burnt lime ..	166	60
Burnt dolomite ..	60	48
Fluorspar ..	-	2

Converter lining

Lining life

The converters are lined with tar-bonded dolomite bricks, the thickness of the lining being 500 mm including the ramming mass next to the shell. The weight of the dolomite brick lining is about 75 tons. The monthly average lining life of the converter and the bottom in 1970/71 is given in Table 2-14.

2 - Steelmelt shop facilities and performance (cont'd)

Table 2-14

MONTHLY AVERAGE LINING LIFE OF THOMAS CONVERTER AND BOTTOM IN 1970/71

Month		Number of heats per lining	
		Converter	Bottom
July 1970	..	156	27
August	..	139	28
September	..	170	25
October	..	152	26
November	..	165	24
December	..	152	22
January 1971	..	175	27
February	..	175	29
March	..	182	28
April	..	173	31
May	..	170	26
June	..	166	29

From Table 2-14, it can be seen that the converter life fluctuates between 139 heats and 182 heats. The bottom life varies from 22 heats to 31 heats.

The average life of the converter and bottom linings during the last three years is given in Table 2-15.

Table 2-15

AVERAGE LIFE OF THOMAS CONVERTER AND BOTTOM LINING DURING 1968/69 TO 1970/71

Year		Number of heats per lining	
		Converter	Bottom
1968/69	..	176	30
1969/70	..	180	30
1970/71	..	164	27

2 - Steelmelt shop facilities and performance (cont'd)

Converter relining time

The average time taken for relining the Thomas converter and changing the converter bottom during the last three years is given in Table 2-16.

Table 2-16

CONVERTER RELINING AND BOTTOM CHANGING TIME

Year	Converter relining time hrs	Bottom changing time hrs
1968/69	91	11.50
1969/70	84	11.00
1970/71	81	11.66

Bottom making

The bottom is rammed with tar dolomite ramming mass in 8 to 9 layers in ramming machines. The weight of the ramming mass is about 4.5 tons. The bottom is built with about 140 tuyeres, each tuyere being 80 cm long and 16 mm in dia. It takes about 8 hours to ram one bottom. After ramming, the bottoms are baked for about 6 days at 750°C in the baking ovens. It is reported that good life is achieved if the bottom is allowed to cool for 4 to 5 days before being put into use.

Electric arc furnace lining

The arc furnace lining consists of tar-dolomite rammed bottom, side walls of tar-dolomite bricks and silica roof. The average life is as follows:

2 - Steelmelt shop facilities and performance (cont'd)

		No. of heats
Bottom	..	300
Sidewall	..	50
Roof	..	65

The approximate time taken for arc furnace relining is 116 hours and for changing the roof 5 hours.

Operating problems

While the arc furnaces have demonstrated their ability to produce around 50,000 tons per year, which is substantially higher than the rated capacity of 36,000 tons, the Thomas converter output has been considerably short of the original rated capacity of 229,000 tons in spite of the subsequent addition of a fourth converter and other facilities. The highest production achieved to date is 205,575 tons in the year 1967/68. Deficiencies in the layout and facilities as well as operating and maintenance problems prevent the present production level being raised substantially.

Impediments to production

The number of heats from the Thomas converters averages 38 per day. With the lining life currently being obtained, it is possible to have in continuous operation two converters out of the four. Assuming 14.5 tons of good ingots per heat, it would be necessary to make 48 heats per day to achieve the rated capacity on the basis of 335 working days per year. But the major bottleneck in increasing the number of heats is the casting car. With a total cycle time of 35 minutes, the casting car is not able to cope with more than an average of 40 heats per day on a sustained basis. Further, when the casting car is inoperative, there is no alternative arrangement for tapping the heat.

For averaging 48 heats per day, 50 to 60 heats may be tapped on several days. This may necessitate simultaneous blowing of two converters on many occasions, depending on the operating conditions. At present, even when two converters are available, only one is blown and the other remains idle. It is reported that two converters cannot be blown simultaneously due to limited supply of air blast.

Another impediment to increasing the production is the extremely congested working conditions in the casting aisle. Adequate space and facilities are not available for mould storage and preparation, casting and stripping, and despatch of ingots. Besides, there are other problems such as frequent breakdown of the monorail trolleys handling burnt lime, high dust content in the burnt lime, difficulty in removing the blast furnace slag and completely pouring out the hot metal from the blast furnace ladles into the mixer, and excessive maintenance delays. Also, adequate quantities of burnt lime from the lime burning plant is not available and the shortfall is being met by purchases from outside sources.

Delay analysis

The breakdown of delays in the Thomas shop for the years 1968/69 to 1970/71 are given in Table 2-17.

Table 2-17

THOMAS SHOP DELAY ANALYSIS

	Hours 1968/69	1969/70	1970/71
Total available converter hours in the year ..	35 040	35 040	35 040
Relining and repairs ..	20 446	20 225	20 224
Converter hours available for operation ..	14 594	14 815	14 816
Delays:			
Production delays (charging, lining repair etc) ..	3 800	4 241	3 474
Shortage of iron/additions	409	724	908
Hydraulic system ..	52	-	-
Mechanical ..	558	482	762
Electrical ..	90	142	495
Power failure ..	15	57	10
Others	304	122	256
Total delays ..	5 226	5 748	5 900
Annual converter hours worked	9 368	9 067	8 916

2 - Steelmelt shop facilities and performance (cont'd)

It will be observed that of the 14,800 hours available for converter operation, the actual hours worked are about 9,000 only. The delays account for about 5,600 hours or 38 per cent of the converter hours available for operation. The bulk of this delay could be attributed to the inadequate facilities and congested layout discussed earlier. However, it may be possible to reduce the delays to some extent, say to about 30 per cent, through better maintenance and co-ordination of the operations. The actual converter operating time would then increase to about 10,360 hours and a production of 225,000 tons could be reasonably achieved. However, for augmenting the production to 330,000 tons per year as envisaged by HADISOLB, it will be necessary to make extensive modifications and reconstruct the steelmelt shop.

3 - ALTERNATIVE SCHEMES FOR RECONSTRUCTION OF THOMAS SHOP

From the foregoing review of the Thomas Shop facilities and performance, it would be clear that the layout is congested, and the equipment and facilities are inadequate to achieve the envisaged production of 330,000 tons of steel from the Thomas converters without carrying out major modifications and reconstruction. The steelmaking process has also to be changed to refine the low phosphorus hot metal that will be made from Bahariya ore instead of the high phosphorus iron now being produced from Aswan ore.

Keeping in view the above considerations, alternative schemes have been worked out for the reconstruction of the Thomas shop. Wherever possible, the existing equipment and facilities have been retained in order to reduce the investments on modifications and new equipment. Before outlining the alternative schemes, it would be relevant to discuss briefly the technological considerations in the choice of steelmaking process in relation to the quality of the hot metal which needs to be refined.

3 - Alternative schemes for reconstruction of Thomas shop (cont'd)

Technological considerations in choice of steelmaking process

Hot metal from Aswan ore

At present, the high phosphorus iron ore from Aswan is used for iron smelting. Typical analyses of the Aswan ore and sinter are shown in Table 3-1.

Table 3-1

ANALYSES OF ASWAN ORE AND SINTER

		Aswan ore %	Sinter %
Fe	..	42.5	36.75
CaO	..	4.3	19.93
SiO_2	..	17.0	18.45
MgO	..	1.9	...
Al_2O_3	..	6.5	...
Mn	..	0.8	...
P	..	1.0	0.50
S	..	0.27	0.25
Ignition loss	..	5.0	...

On account of the high phosphorus content of the iron ore, the hot metal also contains high phosphorus. The average analyses of hot metal is generally as follows:

		Percent
C	..	3.55
Si	..	0.57
Mn	..	1.00
P	..	2.00
S	..	0.05

Hot metal from Bahariya ore

The expansion programme of HADISOLB envisages the use of Bahariya ore for the new blast furnaces as well as the existing ones. This ore, being low in phosphorus, will

3 - Alternative schemes for reconstruction of Thomas shop (cont'd)

yield hot metal with low phosphorus content. Typical analysis of the Bahariya ore and the expected analysis of sinter are as shown in Table 3-2.

Table 3-2

ANALYSES OF BAHARIYA ORE AND SINTER

		Bahariya ore %	Sinter %
Fe	..	52.00	53.49
Fe_2O_3	..	74.30	61.35
CaO	..	1.04	9.91
SiO_2	..	6.70	7.80
MgO	..	0.46	1.10
Al_2O_3	..	1.63	2.70
MnO	..	1.98	1.98
TiO	..	0.10	0.09
SO_3	..	2.35	0.24
P_2O_5	..	0.59	0.59
NaCl	..	1.38	0.59
Ignition loss	..	8.57	0.30

Steelmaking with high phosphorus iron

High phosphorus iron can be refined in the conventional Thomas converter process or in the more modern LD-AC and Kaldo processes. If the existing Thomas converter is to be used in the reconstructed Thomas shop, it will be necessary to increase the phosphorus content of the hot metal made from Bahariya ore from 0.45 per cent to about 1.8 per cent to 2.0 per cent.

5 - Alternative schemes for reconstruction of Thomas shop (cont'd)

It is possible to raise the phosphorus content of the hot metal to this level by adding predetermined quantities of phosphate bearing material to the blast furnace charge. The hot metal quality available will be more or less similar to that obtained with Aswan ore. The phosphorus content in the hot metal can be raised by adding either phosphate rock or Thomas slag in the blast furnace charge or adding ferro-phosphorus in the hot metal ladle. The cost of high phosphorus hot metal with the different additions is estimated as follows:

	Cost per ton of hot metal $
With phosphate rock addition ..	50.33
With Thomas slag addition ..	53.00
With ferro-phosphorus addition in hot metal ..	56.85

From the above it can be seen that the production of high phosphorus hot metal using Bahariya ore will be the most economical when phosphate rock is added to the blast furnace charge. But with this practice, the hot metal production will be about 393,000 tons only.

Steelmaking with low phosphorus iron

Low phosphorus iron is generally refined in the conventional basic open-hearth process or in the modern LD process. The LD-AC and Kaldo processes which are primarily meant for high phosphorus iron, can also be used.

3 - Alternative schemes for reconstruction of Thomas shop (cont'd)

The open-hearth process is becoming obsolete, as LD steelmaking is more economical. Compared to the LD process, the LD-AC and Kalso processes are more expensive to refine low phosphorus iron.

Hot metal for steelmaking by the LD process should preferably have silicon content in the range of 0.6 per cent to 1.0 per cent, sulphur not exceeding 0.05 per cent and phosphorus less than 0.30 per cent. The analysis of hot metal used for LD steelmaking in the leading steel producing countries such as the USA, USSR and Japan falls largely within this range. Though the hot metal that would be obtained with the use of Bahariya ore would analyse 0.45 per cent phosphorus, it is just within the upper limit for the LD process. Accordingly, in one of the alternative schemes, the adoption of LD process has been considered.

<u>OBM process</u>

In recent years, a new process of oxygen steelmaking - the OBM process, also known as Q-BOP and N-BOP - has been developed by the Maximilianshuette of Sulzbach-Rosenberg, West Germany together with L'Air Liquide of Montreal. The OBM process has found its initial application mainly in the Thomas converter shops where the existing Thomas converters have been modified to boost their productivity by 30 to 40 per cent and to improve the steel quality. Also, slopping in the converter is reduced and there is some improvement in the yield.

Several Thomas converter shops in France, Germany, Belgium and Luxembourg in Western Europe have adopted the OBM process. Currently, the OBM capacity is about 14.2 million tons including those under planning. It is reported that a new OBM facility is being planned in South Africa. Also, the US Steel in USA has recently announced the installation of two 200-net ton OBM vessels at Fairfield, Alabama. These will be the largest converters to be installed based on this new process. A list of OBM installations is given in Appendix 3-1.

Briefly, the OBM process involves the blowing of oxygen through the bottom of the converter instead of blowing air as in the conventional Thomas converter. In order to protect the bottom against overheating and damage, the oxygen is blown through double-shell tubes (tuyeres), oxygen being blown through the central tube, and propane or natural gas through the space between the central tube and the outer tube. The LWS process recently developed in France, uses fuel oil in place of propane or natural gas. The dissociation of propane or natural gas provides an endothermic shielding, thereby reducing high temperature and refractory wear in the area where the oxygen emerges from the bottom into the bath. In this process powdered lime is injected along with the oxygen through the tuyeres.

Basic side-blown converter

The low phosphorus hot metal produced from Bahariya ore could also be treated in basic side-blown converters. Iron containing phosphorus as low as 0.3 per cent can be converted into steel, because of the added heat of combustion obtained from burning of CO to CO_2 with surface blowing. Side-blown converters are generally not adopted for large-scale steel production owing to their unfavourable economics. In this study, side-blown converters have been considered at the suggestion of UNIDO as one of the alternatives for the purpose of evaluation.

Remodelling of existing steelmelt shop

In an operating company, remodelling of an existing steelmelt shop is considered to be more advantageous than setting up a new steelmelt shop, if the additional steel requirements are not large. In a number of cases, Thomas converter shops and open-hearth plants have been successfully revamped. Some Thomas shops have recently adopted the new OBM process as listed in Appendix 3-1.

3 - Alternative schemes for reconstruction of Thomas shop (cont'd)

Rebuilding an operating shop poses several problems such as interference with the existing production and the necessity for reducing the construction time to the minimum. However, there are advantages which should be taken into account, the major one being the substantial reduction that could be effected in the capital investment by utilising to the maximum extent the existing building and facilities.

Alternative schemes considered

The following alternative schemes have been considered in this study for reconstruction of the steelmaking facilities at Helwan:

- Alt. 1 - Reconstruction with LD converters
- Alt. 2 - Augmenting production from the existing Thomas converters
- Alt. 3 - Installation of larger capacity Thomas converters
- Alt. 4 - Changeover to OBM (Q-BOP) process, and
- Alt. 5 - Installation of basic side-blown converter

Basic information and technical data on the alternative schemes

Alternative 1 - Reconstruction with LD converters

20-ton LD converters proposed

In this scheme, it is proposed to reconstruct the Thomas converter shop for installing LD converters in the place of the existing Thomas converters. The installation of three

3 - Alternative schemes for reconstruction of Thomas shop (cont'd)

20-ton LD converters (two operating) is envisaged. The size of the converters was selected on economic considerations. For this purpose, an alternative exercise with two 40-ton LD converters (one operating) was carried out. This revealed that reconstruction with 20-ton LD converters would be more economical, as indicated below:

	20-ton LD installation	40-ton LD installation
Estimated reconstruction cost ..	$ 17.37 million	$ 20.50 million
Estimated time of reconstruction ..	36 months	42 months
Shut-down required for reconstruction ..	24 months	30 months
Production cost per ton of ingot including fixed charges ..	$ 87.36	$ 87.94

Design basis

The expected average heat time for a 20-ton LD converter is estimated at 48 minutes tap-to-tap, as indicated in Table 3-3.

3 - Alternative schemes for reconstruction of Thomas shop (cont'd)

Table 3-3

HEAT TIME OF 20-TON LD CONVERTER

Operating		Time minutes
Scrap charging	..	2
Hot metal charging	..	4
Preparation for blowing	..	2
Blowing	..	18
Sampling, temperature measurement etc	..	6
Tapping	..	4
Slagging	..	2
Charge-to-tap	..	38
Tap-to-charge including unforeseen delays	..	10
Total tap-to-tap time	..	48

Based on a tap-to-tap time of 48 minutes, 30 heats per day will be made from each operating converter. The converter lining life has been reckoned at an average of 200 heats. With a converter relining time of 80 hours, it should be possible to have availability of two converters out of three. On this basis, the capacity of the LD converter installation is rated at 380,000 tons of steel ingots per year assuming 335 operating days.

3 - Alternativo schemes for reconstruction of Thomas shop (cont'd)

and additive materials such as burnt lime and ferro-alloys. The material flow sheet is shown in Drawing 519-3-1 and the estimated annual requirements of major raw materials are given in Table 3-5.

Table 3-5

MAJOR RAW MATERIALS REQUIREMENTS - ALT. 1

Major raw materials		Quantity tons/yr
Hot metal	..	372 400
Scrap	..	56 000
Iron oxides	..	8 360
Ferro-alloys etc	..	8 550
Burnt lime	..	34 200

The LD converters will be installed near the present location of the Thomas converters. This arrangement will necessitate major modifications to the existing converter aisle and suitable provision made for the lance handling equipment and high level storage bunkers of converter additions.

The LD converters will be lined with tar dolomite bricks. The existing dolomite calcining and tar dolomite brickmaking facilities will be retained. One new brick press will be provided.

For supplying oxygen for blowing in LD converters, it will be necessary to install a new oxygen plant with a capacity of 125 tons of oxygen per day.

Alternative 2 - Augmenting production from existing Thomas converters

In this alternative, it is proposed to produce 330,000 tons of steel ingots from the existing Thomas converter shop by increasing the total number of heats to 64 per day from the present average of 38 heats per day. This will be possible by operating two converters continuously and charging 19 tons of hot metal per heat. The lining life of the converters and the bottoms has been assumed as 180 and 30 heats respectively, in line with the current performance.

Each operating converter will make 32 heats per day based on a tap-to-tap time of about 45 minutes. The breakdown of tap-to-tap time for a 19-ton (charge weight) heat is given in Table 3-6.

3 - Alternative schemes for reconstruction of Thomas shop (cont'd)

Table 3-6

HEAT TIME OF 19-TON THOMAS HEAT

Particulars		Time minutes
Lime and hot metal charge	..	7
Blowing (including after blow)	..	14
Slagging, sampling etc	..	6
Converter additions	..	3
Tapping	..	3
Slag dumping	..	2
Charge-to-tap	..	35
Tap-to-charge including unforeseen delays	..	10
Total tap-to-tap time	..	45

In this alternative, the existing two 12-ton electric arc furnaces will be retained. In addition to 330,000 tons of ingots from the Thomas converters, about 50,000 tons of ingots will be available from the existing electric furnaces. The design basis for Thomas converters in Alternative 2 is given in Table 3-7.

3 - Alternative schemes for reconstruction of Thomas shop (cont'd)

Table 3-7

DESIGN BASIS - ALT. 2

Particulars		Thomas converters
Number of Thomas converters	..	4
Number of operating converters	..	2
Hot metal charge/heat, tons	..	19
Ingot production/heat, tons	..	16
Tap-to-tap time, minutes	..	45
Number of heats/day/operating converter	..	32
Number of operating days/year	..	335
Converter lining life, heats	..	180
Converter bottom life, heats	..	30
Converter relining time, hours	..	75
Converter bottom changing time, hours	..	12
Number of productive hours per converter lining campaign	..	135
Time required for bottom changing/ campaign	..	60
Duration of one blowing campaign, hours	..	195
Cycle time for one campaign, hours	..	270
Ingot steel production, tons/year	..	330 000

The raw materials required for the process will be high phosphorus hot metal produced by adding phosphate rock to Bahariya ore in the blast furnace charge, flux and additive materials, such as burnt lime and ferro-alloys. The material flow sheet is shown in Drawing 519-3-2 and the estimated annual requirements of major raw materials including those required for the arc furnaces are given in Table 3-8.

3 - Alternative schemes for reconstruction of Thomas shop (cont'd)

Table 3-8

MAJOR RAW MATERIAL REQUIREMENT - ALT. 2

Raw material		Quantity tons/yr
Hot metal	..	382 800
Scrap	..	56 000
Iron oxides	..	4 030
Ferro-alloys etc	..	7 900
Burnt lime	..	51 500

No major modifications to the existing building are envisaged in this alternative and most of the existing facilities could be utilised.

The Thomas converters will be lined with tar dolomite bricks. The existing dolomite calcining, tar dolomite brick-making facilities and the converter bottom-making and drying facilities will be retained. Some additional facilities like a brick press and converter bottom drying ovens will be provided.

New lime calcining facilities will be necessary for supplying additional requirement of burnt lime. It is proposed to install one 60-ton capacity vertical shaft kiln.

<u>Alternative 3 - Larger capacity Thomas converters</u>

This alternative envisages replacement of the existing 17-ton Thomas converters by new 24-ton converters. Of the four converters to be installed, two will be in operation continuously.

3 - Alternative schemes for reconstruction of Thomas shop (cont'd)

It is proposed to enrich the blast by about 30 per cent oxygen by volume. With the oxygen enriched blast, the average heat time for a 24-ton heat is estimated at 48 minutes tap-to-tap as indicated in Table 3-9.

Table 3-9

HEAT TIME OF 24-TON THOMAS CONVERTER

Operations		Time minutes
Charging lime, scrap and hot metal	..	9
Blowing (including after-blow)	..	12
Slagging, sampling etc	..	6
Converter additions	..	4
Tapping	..	4
Slag dumping	..	3
Charge-to-tap	..	38
Tap-to-tap charge including unforeseen delays	..	10
Total tap-to-tap time	..	48

Based on the above heat time, it will be possible to make 30 heats per day from each operating converter. The total number of heats per day from the two operating converters would be 60, thereby producing annually 380,000 tons of steel ingots, based on 335 operating days per year.

The converter availability has been based on an average lining life of 175 heats and bottom lining life of 30 heats.

3 - Alternative schemes for reconstruction of Thomas shop (cont'd)

With a converter relining time of maximum 80 hours, it will be possible to operate two converters out of the four.

As the entire ingot steel production can be made from the 24-ton Thomas converter installation, the existing electric arc furnaces would be shut down and installed elsewhere. The scrap now being consumed by the arc furnaces will be available for use as coolant in the Thomas converter. The design basis for the 24-ton Thomas converters in Alt. 3 is given in Table 3-10.

Table 3-10

DESIGN BASIS - ALT. 3

Particulars		Thomas converters
Total number of converters	..	4
Number of operating converters	..	2
Metallic charge/heat, tons	..	24
Ingot production/heat, tons	..	20
Tap-to-tap time, minutes	..	48
Number of heats/day/converter	..	30
Number of operating days/year	..	335
Converter lining life, heats	..	175
Converter bottom life, heats	..	30
Relining time, hours	..	80
Bottom changing time, hours	..	12
Productive hours per converter lining campaign, hours	..	140
Time required for bottom changing/ campaign, hours	..	60
Duration of one blowing campaign, hours		200
Cycle time for one campaign, hours	..	280
Ingot steel production, tons/year	..	380 000

3 - Alternative schemes for reconstruction of Thomas shop (cont'd)

The raw materials required for the process will be high phosphorus hot metal to be produced by adding phosphate rock to Bahariya ore in the blast furnace charge, scrap, requisite flux and additive materials such as burnt lime and ferro-alloys. The material flow sheet is shown in Drawing 519-3-3 and the annual raw material requirement is given in Table 3-11.

Table 3-11

MAJOR RAW MATERIAL REQUIREMENTS - ALT. 3

Raw material		Quantity tons/yr
Hot metal	..	380 000
Scrap	..	56 000
Iron oxides	..	3 800
Ferro-alloys etc	..	8 550
Burnt lime	..	41 800

The 24-ton Thomas converters will be installed near the present location of the Thomas converters. This arrangement will necessitate modifications to the existing converter aisle.

The Thomas converters will be lined with tar dolomite bricks. The existing dolomite calcining, tar dolomite brick-making and converter bottom drying ovens will be retained. Additional facilities such as brick press, converter bottom drying oven etc need to be installed.

3 - Alternative schemes for reconstruction of Thomas shop (cont'd)

New facilities need to be installed also for meeting the additional requirement of burnt lime. It is proposed to install a 30-ton capacity vertical shaft kiln for lime burning.

Oxygen for enriching the air blast will be supplied by installing an oxygen plant having a capacity of 40 tons of oxygen per day.

<u>Alternative 4 - Changeover to OBM (Q-BOP) process</u>

It is claimed that the investment cost for a new facility would be approximately 20 per cent lower for an OBM shop compared to an LD shop, as the OBM shop does not require the extremely tall buildings associated with LD converters to accommodate the flux bins and the additive system located above the converters. The operation cost is also said to be lower. In view of the attractive economies claimed for the OBM process, its development is being watched with interest by steelmakers all over the world.

With the changeover to OBM process, the charge weight of the existing converters could be increased by about 30 per cent, that is, from the present 17 tons to 22 tons per heat. The tap-to-tap time is estimated at about 45 minutes as shown in Table 3-12.

3 - Alternative schemes for reconstruction of Thomas shop (cont'd)

Table 3-12

HEAT TIME OF 22-TON OBM HEAT

Particulars		Time minutes
Charging scrap and hot metal	..	6
Blowing	..	14
Slagging, sampling, temperature measurement, etc	..	10
Tapping	..	3
Slag dumping	..	2
Charge-to-tap	..	35
Tap-to-charge including unforeseen delays	..	10
Total tap-to-tap time	..	45

Based on the above heat time, it would be possible to make 32 heats per day from each operating converter. However, for rating the capacity, an average of 30 heats per day has been assumed, as this is a recently developed process. The total number of heats per day from the two operating converters would be 60, thereby producing 380,000 tons of steel ingots based on 335 operating days per year.

The life of the OBM converter lining and bottom has been reported as 400 and 200 heats respectively. But, in this study, the converter availability has been based on a conservative lining life of 200 heats and bottom life of about 100 heats. With a maximum relining time of 86 hours,

3 - Alternative schemes for reconstruction of Thomas shop (cont'd)

it would be possible to operate two converters out of three. Hence, it would be necessary to modify only three of the existing four Thomas converters and dismantle the fourth one.

As the entire ingot steel production can be met by the OBM installation, the existing electric arc furnaces would be shut down and installed elsewhere. The scrap used in the electric arc furnaces will be available for use as coolant in the OBM converters.

The design basis for the 22-ton OBM converter envisaged in Alternative 4 is given in Table 3-13.

Table 3-13

DESIGN BASIS - ALT. 4

Particulars		OBM converter
Number of converters	..	3
Number of operating converters	..	2
Metallic charge/heat, tons	..	22
Ingot production/heat, tons	..	19
Tap-to-tap time, minutes	..	45
Number of heats/day/operating converter	..	30
Number of operating days	..	335
Converter lining life, heats	..	200
Converter bottom life, heats	..	100
Converter relining time, hours	..	86
Number of productive hours per converter lining campaign, hours	..	160
Time required for bottom changing/campaign		12
Duration of one blowing campaign, hours	..	172
Cycle time for one campaign, hours	..	258
Ingot steel production, tons/year	..	380 000

3 - Alternative schemes for reconstruction of Thomas shop (cont'd)

The raw materials required for the process will be low phosphorus hot metal produced from Bahariya ore, scrap, requisite flux and additive materials such as burnt lime and ferro-alloys. The material flow sheet is shown in Drawing 519-3-4, and the annual raw material requirement is given in Table 3-14.

Table 3-14

MAJOR RAW MATERIAL REQUIREMENTS - ALT. 4

Raw material		Quantity tons/yr
Hot metal	..	370 500
Scrap	..	56 000
Iron oxides	..	7 980
Ferro-alloys etc	..	8 550
Burnt lime	..	34 200

Other than the modifications to the convertor bottom, minor modifications to the existing building and facilities will be required in this alternative. Additional facilities will include flux grinding plant and oxygen plant. It is proposed to install a 125-ton per day capacity oxygen plant and to purchase propane.

The OBM convertors will be lined with tar dolomite bricks. The existing dolomite calcining and tar dolomite brickmaking facilities will be retained, and additional facilities like brick press etc will be installed.

3 - Alternative schemes for reconstruction of Thomas shop (cont'd)

Alternative 5 - Basic side-blown convertors

In this alternative, it is proposed to replace the existing Thomas convertors by basic side-blown convertors. For producing 330,000 tons of steel ingots, four 28-ton (charge weight) side-blown convertors, with two converters in operation, would be required. Each operating convertor will make 25 heats per day, based on a tap-to-tap time of about 57 minutes as shown in Table 3-15.

Table 3-15

HEAT TIME OF 28-TON SIDE-BLOWN CONVERTER

Particulars		Time minutes
Charging lime and hot metal	..	6
Blowing	..	27
Slagging, sampling etc	..	6
Converter additions	..	3
Tapping	..	3
Slag dumping	..	2
Charge-to-tap		47
Tap-to-charge including unforeseen delays	..	10
Total tap-to-tap time	..	57

The total number of heats per day from the two operating converters would be 50, thereby producing 330,000 tons of steel ingots on the basis of 335 operating days per year.

3 - Alternative schemes for reconstruction of Thomas shop (cont'd)

The lining life of the side-blown converter is low. Assuming a lining life of 70 heats, it would be possible to operate two converters, out of the four. The time available for relining one converter would be 80 hours.

The existing two 12-ton electric arc furnaces will have to be retained.

The design basis for the 28-ton basic side-blown converter is given in Table 3-16.

Table 3-16

DESIGN BASIS - ALT. 5

Particulars		Side-blown converter
Number of converters	..	4
Number of operating converters	..	2
Hot metal charge/heat, tons	..	28
Ingot production/heat, tons	..	24
Tap-to-tap time, minutes	..	57
Number of heats/day/converter	..	25
Number of operating days per year	..	335
Converter lining life, heats	..	70
Converter relining time, hours	..	80
Productive hours per lining campaign, hours		68
Time required for tuyere changing per campaign, hours	..	12
Duration of one blowing campaign, hours		80
Cycle time for one campaign, hours	..	160
Ingot steel production, tons/year	..	330 000

3 - Alternative schemes for reconstruction of Thomas shop (cont'd)

The raw materials required will be low phosphorus hot metal produced from Bahariya ore, and additive materials such as burnt lime and ferro-alloys. The material flow sheet is shown in Drawing 519-3-5 and the annual raw materials requirement is given in Table 3-17.

Table 3-17

MAJOR RAW MATERIALS REQUIREMENTS - ALT. 5

Raw materials		Quantity tons/yr
Hot metal	..	384 500
Scrap	..	56 000
Iron oxides	..	2 380
Burnt lime	..	31 700
Ferro-alloys etc	..	7 900

The side-blown convertors will be lined with tar dolomite bricks. In addition to the existing dolomite calcining and tar dolomite brickmaking facilities which will be retained, the installation of two dolomite shaft kilns of 25-tons capacity per day each would be required. Additional facilities for raw dolomite and coke storage and conveying, storage and heating of tar, crushing, screening, storage and batching of burnt dolomite, preparation of tar dolomite mix and dolomite brickmaking, will have to be provided.

3 - Alternative schemes for reconstruction of Thomas shop (cont'd)

The side-blown convertors will be installed near the location of the existing Thomas convertors. This arrangement will involve major modifications to the building.

4 - MODIFICATIONS AND ADDITIONAL FACILITIES REQUIRED

The discussion in this chapter mainly relates to the equipment, material handling and other ancillary facilities required for the five alternatives outlined in Chapter 3. The details and the magnitude of the construction work involved in the modifications and additions are discussed in Chapter 6. Reference to the construction details in this chapter is, therefore, only incidental and intended to enable overall visualisation of the five schemes. It will be appreciated that the reconstruction schemes discussed below are tentative and further detailed study has to be made on the selected scheme.

ALTERNATIVE 1 - RECONSTRUCTION WITH LD CONVERTERS

Alternative 1 envisages installation of three 20-ton LD converters with two in operation. The converters will be installed in the existing converter aisle, after dismantling the Thomas converters. The major existing facilities to be retained are given in Appendix 4-1 and the major new facilities to be installed are listed in Appendix 4-2.

20-ton LD converters

Drawing 519-4-1 shows the tentative layout of the proposed LD steelmaking facilities.

4 - Modifications and additional facilities required (cont'd)

Converter aisle modifications

Reconstruction of converter aisle

The existing converter aisle will be reconstructed suitably for installing the LD converters and their ancillary facilities. The three converters will be installed at 15 m centres in the Thomas converter aisle as follows:

i) The first LD converter will be installed between the existing columns D7 and D8. This will involve dismantling of the columns in row 8, and the installation of new columns in row 8', located 15 m from the centre line of the column row 7.

ii) The second LD converter will be installed between the existing columns D7 and D5. The columns in row 6, will be dismantled and new columns in row 6' will be installed. The centre line of the new column row 6' will be 15 m away from the centre line of the existing column row 7.

iii) The third LD converter will be located between the existing columns D5 and D4. Columns in row 5 will be dismantled.

4 - Modifications and additional facilities required (cont'd)

The existing working platform at 6 m above the floor level will be dismantled and a new platform erected in its place, and extended into the casting aisle to form the LD converter working platform. The other platforms as well as the four fume stacks and the overhead lime bins will also be dismantled. New platforms at different levels will be provided for flux storage and handling facilities, oxygen lance system and for services and relining work of the converter.

Steel handling

Liquid steel from the LD converter will be tapped into the new 25-ton capacity steel ladles carried on rail-mounted self-propelled transfer car installed below the converter. The track will extend to the new casting aisle, where the ladle will be hoisted by the overhead casting crane and the heat teemed. The existing casting car will be dismantled.

Slag handling

The slag from the LD converter will be poured into 3 cu m capacity slag pot placed on a car running on track below the converter. The loaded slag pot will be removed to the existing slag yard for disposal of the slag.

Lime handling

Burnt lime and other flux materials will be transported to the existing lime aisle in rail wagons and manually unloaded into 1.5 cu m buckets. The buckets will

4 - Modifications and additional facilities required (cont'd)

be lifted by the existing 3-ton capacity overhead crane and the materials discharged into the existing overhead bunkers. The four overhead bunkers will be suitably modified and fitted with vibrating feeders to discharge flux materials directly into a belt conveyor which, in turn, will feed a bucket elevator. The bucket elevator will raise the materials and deliver them to another conveyor system feeding the high level bins in the converter aisle.

The existing mono-rail system for lime transfer will be dismantled.

Scrap handling

The electric furnaces will be shut down and the furnaces and ancillary equipment dismantled. The space available will be utilised for scrap storage and preparation. The existing 16/3-ton overhead crane will be equipped with a magnet for handling scrap. Scrap will be cross-transferred to the mixer and charging aisle on a transfer car running on a track to be provided between column rows 16 and 17. On entering the mixer and charging aisle, the transfer car will turn through 90° on a turn-table, and then run on another track laid adjacent and parallel to D row of columns up to column D10.

A new track for incoming scrap will enter the scrap aisle from the northern end.

4 - Modifications and additional facilities required (cont'd)

The existing scrap yard will also be used for scrap storage and the cross-transfer track, running between column rows 16 and 17, will extend to this yard.

Mixer and charging aisle

The existing mixer and casting aisle will be used as mixer and charging aisle for the LD converters. All the existing facilities located between column rows 3 and 20 in this aisle including the casting car, casting pits and mould preparation facilities will be dismantled. The existing 25/5-ton hot metal charging crane will be modified into a scrap charging crane. The 10-ton stripper crane and 25/5-ton casting crane for electric furnace heats, will be dismantled and relocated in the new casting aisle.

Existing facilities to be dismantled

Hot metal from the blast furnaces will be transported to this aisle in the blast furnace ladles. The ladle will be hoisted by one of the two existing 50/10-ton mixer cranes and the hot metal poured into the mixer. The 50/10-ton hot metal charging crane will also be used for charging hot metal into the LD converter.

Hot metal handling

The space available by dismantling the existing casting and ingot mould handling facilities will be utilised for the storage, cooling and preparation of ingot moulds. The existing 10-ton mould handling crane will be

Ingot mould handling

used for handling the moulds. Two cross-transfers will be located between column rows 11 and 12, and 14 and 15 for transferring ingot moulds to and from the new casting aisle, where the ingot moulds will be handled by the new overhead casting crane. Space will be provided at the northern end of the aisle for the storage of new and rejected ingot moulds.

A railway track will enter the aisle for the transportation of ingot moulds and other miscellaneous materials.

New casting aisle

New casting aisle facilities

It is proposed to construct a new aisle parallel and adjacent to the existing mixer and casting aisle for the casting and stripping of ingots. The aisle will be 170 m long and 22.25 m wide between the crane rails. Suitable facilities for casting and stripping ingots and for ladle preparation will be provided.

Two new casting cranes of 50/10-ton capacity will be installed in this aisle. The 25/5-ton ladle crane, relocated in this aisle, will be used as a service crane for handling the empty ladles etc. The relocated stripper crane will strip the moulds and load the ingots on to box cars for despatch to the soaking pits.

4 - Modifications and additional facilities required (cont'd)

Dolomite calcining and brickmaking facilities

Dolomite facilities to be retained

The two existing dolomite shaft kilns and their ancillary equipment, including the dolomite and coke storage, conveying and charging facilities etc, will be retained. The facilities for crushing, screening and batching of burnt dolomite, the tar storage and heating installations and the units for preparing the tar dolomite mix will also be retained. The Thomas converter bottom preparation and drying facilities will be dismantled. One new brick press will be installed near the column D13. An airconditioned storage room will be provided in the existing bottom making aisle. The existing 12/5-ton overhead crane in this aisle will be utilised for handling the tar dolomite bricks.

LD gas cooling and cleaning system

LD gas cleaning

The gas emitted from the LD convertor during blow will be burnt in the hood and led through a water-cooled gas cooler and spray cooler to the wet gas cleaning plant. The gas cleaning plant will comprise venturi scrubber for cleaning and quenching of hot gases. The gases emitted from the converter will be drawn through the cooling and cleaning system by an exhaust fan. After cooling and cleaning, the waste gases will be exhausted to the atmosphere through a stack.

4 - Modifications and additional facilities required (cont'd)

A sludge recovery and water circulation system will be provided with the gas cleaning plant.

ALTERNATIVE 2 - AUGMENTING PRODUCTION FROM EXISTING THOMAS CONVERTERS

It is proposed to increase the number of heats from the existing four Thomas converters by providing certain additional facilities so that it is possible to operate two converters regularly. This alternative envisages the utilisation of the existing facilities to be maximum extent possible. The two existing electric furnaces and ancillary facilities will be retained. The major existing facilities to be utilised are listed in Appendix 4-3. The list of major new facilities required is given in Appendix 4-4.

Drawing 519-4-2 shows the layout of the steelmelt shop with the proposed modifications.

Converter aisle

The existing converters will be retained. For transferring liquid steel to the new casting aisle, four self-propelled ladle transfer cars will be provided. The existing casting car will be dismantled. The handling of hot metal, flux, scrap and slag will remain same as in the current practice.

4 - Modifications and additional facilities required (cont'd)

Mixer and charging aisle

New facilities

The working platform at 6 m above floor level will be extended further by about 8 m in the mixer and charging aisle for providing additional working space. All the existing facilities between column rows 9 and 15 in this aisle will be dismantled. This space will be utilised for the storage and preparation of ingot moulds. Two cross-transfers will be provided for transferring ingot moulds to and from the new casting aisle. The existing 25/5-ton casting and 10-ton stripper cranes will be dismantled and relocated in the new casting aisle.

This aisle will be extended by 20 m, i.e. two bays of 10 m each towards the northern end of the building. The space available by extension will be utilised for installing electric furnace ladle preparation facilities.

Electric furnace aisle and scrap yard

Electric furnaces retained

All the existing facilities in the electric furnace aisle and scrap yard will be retained. The electric furnace aisle will be extended by 20 m, i.e. two bays of 10 m each. In this extended area, space will be provided for relining the furnace roof.

New casting aisle

A new casting aisle adjacent and parallel to the existing casting aisle will be constructed for casting and stripping ingots. The dimensions of this aisle and the facilities installed will be generally similar to those envisaged in Alternative 1.

Dolomite and bottom-making facilities

Dolomite facilities to be retained

The two existing dolomite shaft kilns and their ancillary equipment, including the dolomite and coke storage, conveying and charging facilities etc, will be retained. The existing facilities for crushing, screening and batching of burnt dolomite, the tar storage and heating installations and the units for preparing the tar dolomite mix will be retained. One new brick press will be installed in the existing ladle preparation aisle to meet the additional requirement of dolomite bricks.

The existing Thomas converter bottom preparation and drying facilities will be retained. To meet the additional requirement of converter bottom, four new bottom-baking ovens will be installed in the existing ladle aisle. The ladle preparation facilities in this aisle will be dismantled as new facilities will be installed in the new casting aisle. To facilitate the handling of the converter bottom and dolomite bricks, the travel of the existing 12.5-ton crane in the dolomite and bottom aisle (B-D aisle) will be extended to the ladle aisle, dismantling the column common to both C and F column rows.

4 - Modifications and additional facilities required (cont'd)

Blower plant

The existing blowers and hydraulic pumps will be retained. One new blower and a new high pressure centrifugal pump identical to the existing ones will be provided.

ALTERNATIVE 3 - NEW 24-TON CAPACITY THOMAS CONVERTERS

New 24-ton Thomas converters

In this alternative, it is proposed to increase the production from the existing steelmelt shop by providing four 24-ton capacity Thomas converters in the place of the existing 17-ton converters. The major existing facilities to be utilised are listed in Appendix 4-5. The list of major new facilities required is given in Appendix 4-6.

Drawing 519-4-3 shows the tentative layout of the steelmelt shop with the modifications proposed in this alternative.

Electric furnaces redundant

The existing two 12-ton arc furnaces will become redundant in this alternative. The scrap yard and the electric furnace aisles will be utilised for the storage and preparation of scrap for the Thomas converters. Scrap handling will be similar to that envisaged for Alternative 1.

The handling of hot metal, flux and slag will be same as in the existing practice. All the existing equipment in the ladle aisle will be dismantled.

4 - Modifications and additional facilities required (cont'd)

Converter aisle

New Thomas converter location

The existing converter aisle will be reconstructed suitably to accommodate the 24-ton Thomas converters. The converters will be installed in the existing converter aisle at a centre line distance of 12 m. The tentative locations of the three converters will be as follows:

i) The first converter will be installed between the existing columns D7 and D9. This will require dismantling of the columns in row 8.

ii) The second converter will be installed at the location of the existing column D7. The existing column row 7 will be dismantled and new column row 7' will be installed. The centre line distance of the new column row 7' will be 6 m from the centre line of the existing column row 7.

iii) The third converter will be installed between the existing columns D5 and D6. It will be required to dismantle the existing column row 6 and install new column rows 6' and 5'. The centre line distance of the new column row 6' will be about 4 m from the existing column row 6. The centre line of the new column row 5' will be at a distance of 2.5 m from the centre line of the existing column row 5.

iv) The fourth converter will be installed between the existing column rows 4 and 5. The columns in row 5 will be dismantled.

The existing platform at 6 m above the floor level will be dismantled and a new platform constructed at the same height, and extended to the casting aisle.

4 - Modifications and additional facilities required (cont'd)

Liquid steel handling

The liquid steel from the Thomas converter will be poured into the new 25-ton capacity steel ladle placed on a self-propelled transfer car installed on the track below the converter. The track will extend to the new casting aisle, where the ladle will be lifted by the overhead casting crane and taken for casting. The existing casting car will be dismantled.

New casting aisle

The dimensions and the facilities provided in the new casting aisle will be generally similar to those envisaged for Alternative 1. The existing casting area will be used for mould storage and preparation as in the case of Alternative 1.

Dolomite calcining and brickmaking facilities

Dolomite facilities to be retained

The existing dolomite calcining, brickmaking, bottom-making and bottom drying facilities will be retained. One new dolomite brick press will be provided in the existing ladle aisle. Two new bottom-baking ovens will be installed in the same aisle. To facilitate the handling of converter bottoms and dolomite bricks, the travel of the existing 12.5 ton crane in the dolomite preparation aisle (B-D aisle) will be extended to the existing ladle aisle also, by dismantling the column common to both C and F column rows.

4 - Modifications and additional facilities required (cont'd)

Blower plant

The existing blowers and high pressure pumps will be retained. One new blower and a new high pressure centrifugal pump for the hydraulic system will be provided.

ALTERNATIVE 4 - MODIFICATIONS TO ADOPT OBM (Q-BOP) PROCESS

Change over to OBM

This alternative envisages modifications to three of the four existing Thomas converters to adopt OBM (Q-BOP) process. Out of the three OBM converters, two will always be in operation. The fourth Thomas converter will be dismantled. The major existing facilities to be utilised are listed in Appendix 4-7 and the list of major new facilities is given in Appendix 4-8. A tentative layout of the proposed OBM facilities in the steelmelt shop building is given in Drawing 519-4-4.

Electric furnace redundant

The two existing arc furnaces will become redundant in this alternative also. Due to the change in the steelmaking technology, the existing blowers will become redundant. The ladle preparation facilities will be dismantled and the ladle aisle will remain unutilised.

Facilities will be provided for storage of propane etc required for injecting into the OBM converter.

4 - Modifications and additional facilities required (cont'd)

Scrap, hot metal and slag handling

The scrap aisle, scrap yard, mixer and charging aisle, and the new casting aisle will be similar to those described in Alternative 1. The handling of hot metal, scrap, slag and ingot moulds will be generally similar to those envisaged for Alternative 1.

Converter aisle

Modifications for OBM

The existing Thomas converter will be provided with modified bottom for adopting the OBM process. The liquid steel from the converter will be poured into 25-ton capacity steel ladle placed on self-propelled transfer car installed below the converter. The track will extend to the new casting aisle, where the ladle will be lifted by the overhead casting crane and taken for casting. The existing casting car will be dismantled.

Flux grinding plant

New flux grinding facilities

A grinding plant of suitable capacity will be installed in the existing lime aisle. The aisle will be extended by 20 m, i.e. two bays of 10 m each, towards the southern end of the building. The existing lime bunkers will be dismantled and new storage bins as well as pressurised bins for burnt lime and other fluxes will be installed.

4 - Modifications and additional facilities required (cont'd)

Dolomite calcining and brickmaking facilities

Dolomite facilities to be retained

The two dolomite shaft kilns and their ancillary equipment including the limestone and coke storage, conveying and charging facilities etc will be retained. The facilities for crushing, screening and batching of burnt dolomite, the tar storage and heating installations, tar dolomite mix preparation and converter bottom preparation and drying facilities will also be retained. One additional brick press will be installed. The existing 12.5-ton overhead crane in this aisle will be utilised for handling tar dolomite bricks and converter bottoms.

ALTERNATIVE 5 - INSTALLATION OF SIDE-BLOWN CONVERTERS

Four 28-ton side-blown converters

This alternative envisages installation of four 28-ton basic side-blown converters after dismantling the existing Thomas converters. The two electric arc furnaces and their ancillary facilities will be retained. The list of major existing facilities to be utilised is given in Appendix 4-9. The facilities to be provided are listed in Appendix 4-10.

The proposed layout of the side-blown converters and the modifications to the steelmelt shop building is shown in drawing 519-4-5.

4 - Modifications and additional facilities required (cont'd)

The handling of hot metal, scrap, liquid steel, fluxes, slag and ingot mould will be generally similar to those envisaged for Alternative 2.

Converter aisle

Side-blown converter location

The existing converter aisle will be reconstructed suitably for installing the 28-ton side-blown converters at 12 m centres. The tentative locations of the three converters will be as follows:

i) The first converter will be installed between the existing columns D7 and D9. This will involve dismantling of the column row 8.

ii) The second converter will be installed at the location of existing column D7. The existing column rows 7 will be dismantled and new column row 7' will be installed. The centre line distance of the new column row 7' will be 6 m from the centre line of the existing column row 7.

iii) The third converter will be installed between the existing columns D5 and D6. It will be necessary to dismantle the existing column row 6 and install new column rows 6' and 5'. The centre line distance of the new column row 6' will be about 4 m from the existing column row 6. The centre line of the new column row 5' will be at a distance of 2.5 m from the centre line of the existing column row 5.

iv) The fourth converter will be installed between the existing column rows 4 and 5.

4 - Modifications and additional facilities required (cont'd)

The existing platform at 6 m above the floor level will be dismantled and a new platform will be constructed in its place.

Liquid steel handling

Liquid steel from the side-blown converters will be poured into new 30-ton capacity steel ladle placed on self-propelled transfer car on the track below the converter. The track will extend to the new casting aisle where the ladle will be lifted by the overhead casting crane and taken for casting. The existing casting car will be dismantled.

Mixer and charging aisle

Facilities to be dismantled

All the existing facilities between column rows 9 and 15 in this aisle will be dismantled. This space will be utilised for the storage and preparation of ingot moulds. Two cross-transfers will be provided for transferring ingot moulds to and from the new casting aisle. The existing 25/5-ton casting and 10-ton stripper cranes will be dismantled and relocated in the new casting aisle.

This aisle will be extended by two bays of 10 m each towards the northern end of the building. The space will be utilised for installing electric furnace ladle preparation facilities.

4 - Modifications and additional facilities required (cont'd)

Electric furnace aisle and scrap yard

Electric furnaces retained

All existing facilities will be retained. The electric furnace aisle will be extended by 20 m, i.e. 2 bays of 10 m each to provide space for the electric furnace roof relining facilities.

New casting aisle

Casting facilities

A new casting aisle adjacent and parallel to the existing mixer and casting aisle will be similar to the one envisaged for Alternative 1. Suitable facilities for casting and stripping of ingots, ladle preparation facilities etc will be provided.

Dolomite and bottom-making facilities

Facilities to be retained

The two existing dolomite shaft kilns and their ancillary equipment including the dolomite and coke storage, conveying and charging facilities etc will be retained. The existing facilities for crushing, screening and batching of burnt dolomite, the tar storage and heating installations and the units for preparing the tar dolomite bricks will also be retained.

New dolomite kilns

To meet the additional demand of dolomite bricks, two new dolomite shaft kilns of 25-ton capacity per day each will be installed in the existing ladle aisle. Additional facilities for the storage and feeding of raw dolomite and coke, crushing, screening, storage and batching of burnt dolomite, storage and heating installations for tar, and preparation of tar dolomite mix will be provided. One new brick press will also be installed in the existing ladle aisle to meet the additional requirement of dolomite bricks.

Blower plant

The existing blowers and high pressure pumps will be retained. One new blower and a new high pressure centrifugal pump will be installed.

5 - SERVICES AND UTILITIES

LIME CALCINING PLANT

Existing lime burning plant

The lime burning plant, comprising two blast furnace gas-fired vertical kilns, provides burnt lime for the Thomas converter shop and electric arc furnaces. The kiln installation was designed for a total daily production of 140 tons, but the actual output at present is only about 96 tons. The shortfall is being met through purchases from outside sources.

The lime kilns are located near the blast furnaces, adjacent to the high line from where limestone is unloaded from wagons into the feed bins. Burnt lime is transported to the steelmelt shop by rail.

Requirements and shortfalls of lime

The annual requirements of burnt lime under different alternatives have been estimated on the basis of the process requirements. The annual availability from the existing kilns has been worked out, assuming 96 tons per day and 340 days per year which comes to 32,640 tons. Table 5-1 shows the demand, availability and shortfall for the five alternatives.

5 - Services and utilities (cont'd)

Table 5-1

ANNUAL SHORTFALL OF BURNT LIME

	Requirements tons/yr	Availability tons/yr	Shortfall tons/yr
Alt. 1 ..	34 200	32 640	1 560
Alt. 2 ..	51 500	32 640	18 860
Alt. 3 ..	41 800	32 640	9 160
Alt. 4 ..	34 200	32 640	1 560
Alt. 5 ..	31 700	32 640	-

Additional lime burning facilities

It may be noted that the production from the existing lime burning plant will be adequate to meet the lime requirement in Alternative 5. The additional requirements for the Alternatives 1 and 4 are marginal and could be purchased from outside sources.

For Alternatives 2 and 3, it is proposed to install one vertical shaft kiln with a capacity of 60 tons/day and 30 tons/day respectively.

The new kiln is proposed to be installed in the existing calcining plant area. Storage bunkers will be provided for storing the incoming raw materials. Limestone will be charged into the kiln by means of a skip hoist. The kiln is proposed to be fired with fuel oil/blast furnace gas. The burnt lime will be transported to the steelmelt shop by rail.

DOLOMITE CALCINING AND BRICKMAKING PLANT

Existing dolomite burning plant

Dolomite burning plant consists of two coke-fired vertical kilns located in the steelmelt shop building. The kilns were designed for a total daily output of 30 tons, but the actual output is about 45 tons.

Requirements and shortfalls of burnt dolomite

The annual requirements of burnt dolomite under the various alternatives have been estimated on the basis of the converter lining life envisaged for the different processes. The annual availability from the existing kilns will be about 14,850 tons, assuming an output of 45 tons per day and 330 operating days per year. Allowing 5 per cent loss, the availability will be 14,100 tons. Table 5-2 shows the demand, availability and shortfall for the different alternatives.

5 - Services and utilities (cont'd)

Table 5-2

ANNUAL SHORTFALL OF BURNT DOLOMITE

	Requirements tons/yr	Availability tons/yr	Shortfall tons/yr
Alt. 1 ..	6 840	14 100	-
Alt. 2 ..	13 780	14 100	-
Alt. 3 ..	12 770	14 100	-
Alt. 4 ..	7 860	14 100	-
Alt. 5 ..	23 000	14 100	8 900

The demand, availability and the shortfalls of tar dolomite mix for bottom-making and dolomite bricks are shown in Table 5-3.

Table 5-3

ANNUAL SHORTFALL OF TAR DOLOMITE MIX AND BRICKS

	Tar dolomite mix			Tar dolomite bricks		
	Requirement tons/yr	Availability tons/yr	Shortfall tons/yr	Requirement tons/yr	Availability tons/yr	Shortfall tons/yr
Alt. 1	7 880	14 850	-	7 500	6 000	1 500
Alt. 2	14 500	14 850	-	11 060	5 000	5 060
Alt. 3	13 440	14 850	-	11 000	6 000	5 000
Alt. 4	8 280	14 850	-	7 200	6 000	1 200
Alt. 5	24 200	14 850	9 350	21 500	6 000	15 500

5 - Services and utilities (cont'd)

Additional facilities

It may be noted that the production from the existing dolomite kilns will be adequate to meet the burnt dolomite requirement in Alternatives 1, 2, 3 and 4. The additional requirement of burnt dolomite in Alternative 5 will be met by installing two identical kilns in the existing ladle preparation aisle. Storage facilities for the incoming dolomite will be provided adjacent to the existing storage area. Additional facilities for preparation of tar dolomite mix will be provided in Alternative 5. To meet the additional requirement of tar dolomite bricks, necessary brickmaking facilities will be provided.

OXYGEN PLANT

Oxygen is required for steelmaking by LD process envisaged under Alternative 1 and for OBM process under Alternative 4. It is also proposed to enrich the air blast for Thomas converters with oxygen under Alternative 3. Oxygen will not be required for steelmaking in Alternatives 2 and 5.

Oxygen requirement

The requirements of oxygen for the different alternatives are indicated in Table 5-4.

5 - Services and utilities (cont'd)

Table 5-4

REQUIREMENT OF OXYGEN

Alternative		Maximum flow rate N cu m/hr	Daily requirement tons	Annual requirement tons
Alt. 1	..	7 200	110	32 100
Alt. 3	..	3 400	35	8 850
Alt. 4	..	4 960	104	32 300

Oxygen plant capacity

The maximum flow rates under Alternatives 1 and 3 are estimated for simultaneous operation of two converters. The oxygen plant capacity has been determined on the basis of the average daily requirement and the maximum flow rate. It is proposed to install one oxygen plant of 125 tons per day capacity in Alternative 1, whereas under Alternative 3 the plant capacity will be 40 tons per day. For steelmaking by OBM process envisaged under Alternative 4, the plant capacity will be 125 tons per day.

Oxygen storage facilities

For all the alternatives, the oxygen plant will be operating on the low pressure cycle and will be capable of producing 6 to 7 per cent of its capacity in liquid form. The purity of oxygen will be over 99.5 per cent.

5 - Services and utilities (cont'd)

Liquid oxygen storage with vapourisation facilities will be provided to augment oxygen supply during emergency or planned shut-down of the oxygen plant. Provision is kept for generation of 99.5 per cent nitrogen also.

Oxygen generated will be compressed for distribution to the steelmelting shop and for general purpose use. The discharge pressure of the oxygen compressors will be 35 kg/cm^2 g for Alternative 1; 8 kg/cm^2 g for Alternative 3; and 15 kg/cm^2 g for Alternative 4. Suitable gaseous oxygen buffer vessels will be provided near the steelmelting shop to take care of the peak demands.

POWER DISTRIBUTION SYSTEM

The overall estimated power requirement under the different alternatives for the steelmelt shop is given in Table 5-5.

Table 5-5

ESTIMATED POWER REQUIREMENTS

	Alt. 1	Alt. 2	Alt. 3	Alt. 4	Alt. 5
30-min maximum demand, MW ..	5.0	18.5	9.25	6.0	17.5
Total annual energy consumption in million kWh ..	31.5	77.7	51.8	35.0	73.2
Overall power factor ..	0.85	0.85	0.85	0.85	0.85

5 - Services and utilities (cont'd)

Power availability

The power is being supplied at 63 kV to the plant from Cairo South Power Station (thermal) having 4 x 60 MW generating sets. Cairo South is connected through 63 kV grid to EI Tabbin (thermal and gas) station having 3 x 15 MW generation sets and to Aswan Dam (hydel) with 12 x 185 MW generating sets.

The plant has two stepdown stations, one having 4 x 20 MVA, 63/6.6 kV transformers feeding the blast furnace, steelmelt shop and rolling mill complex, and second with 4 x 25 MVA, 63/6.6 kV transformers for strip mill plant. The plant's maximum demand is 42.8 MW for the blast furnace, steelmelt shop and rolling mill complex, and 100 MW when the strip mill is also taken into consideration.

The steelmelt shop sub-station is fed from the main receiving station over two feeders, one with 4 per leg, 3-core, 150 sq mm cables and second with 3 per leg, 3-core, 150 sq mm cables. The existing two 6,000 kVA electric arc furnace transformers are fed directly from the main receiving station at 6.6 kV.

The maximum demand of the steelmelt shop, comprising the Thomas converters, electric arc furnaces and other loads connected to the steelmelt shop sub-station, works out to 15,948 kW. In Alternatives 1, 3 and 4, it is proposed that the two 12-ton electric arc furnaces would be shut down. As a result of this, there would be surplus power available on the system as a whole. In Alternatives 2 and 5, since the arc furnaces would be in service, there is an additional demand of 1,500 to 2,500 kW on the system, which can be met by strengthening the 6.6 kV feeders from the main receiving sub-station to the steelmelt shop sub-station.

<u>High-tension power distribution system</u>

As mentioned earlier in Alternatives 1, 3 and 4, the arc furnaces would be shut down, and therefore, it is assumed for the purpose of this report that the two arc furnace feeders would be used for establishing a separate area sub-station for the new plant loads coming in these alternatives. The proposed new sub-station would be located adjacent to the oxygen plant where the bulk of the additional load is concentrated. The new sub-station would also feed additional load-centre sub-stations required for auxiliary loads.

For Alternatives 2 and 5, there is an additional demand of about 1,500 to 2,500 kW on the system. The firm feeder capacity from the main receiving sub-station to the steelmelt shop sub-station is the capacity of the feeder with 3 per leg, 150 sq mm cables when the other feeder with 4 per leg, 150 sq mm cables is out of service for any reason. The firm capacity will therefore be about 6.5 MVA, which is considered to be just adequate for the present load. To meet the additional demand of the new plant loads, it is proposed to strengthen the existing 6.6 kV feeders to the steelmelt shop area sub-station, each feeder comprising 5 per leg, 3-core, 150 sq mm cables. This will necessitate adding 3 more cables in the two existing 6.6 kV feeders. If, for any reason, the above arrangement cannot be implemented, then two additional feeders have to be provided from the main receiving sub-station to the steelmelt shop area. In case of Alternatives 2 and 5 also, a new sub-station will be established for connecting to different load-centre sub-stations to meet additional loads.

Medium and low-tension system

To meet the requirements of auxiliary power, it is proposed to install 6.6 kV/380-220 volt, load-centre sub-stations as given in Table 5-6 for different alternatives.

5 - Services and utilities (cont'd)

Table 5-6

6.6 kV/380-220 VOLT LOAD-CENTRE SUB-STATIONS

	Alt. 1 No.	Alt. 2 No.	Alt. 3 No.	Alt. 4 No.	Alt. 5 No.
2 x 1,250 kVA	-	-	1	1	-
2 x 1,000 kVA	1	2	1	-	-
2 x 500 kVA	1	2	2	-	-
1 x 1,000 kVA	-	-	-	1	2
1 x 500 kVA	-	-	-	1	1

From the load-centre sub-station boards, power will be carried to individual power consumers over sub-distribution boards and motor control centres located at appropriate load-centres. All electrical inter-connections will be done over PVC insulated, PVC sheathed armoured/unarmoured cables as required.

Motors and controls

All motors selected shall be tropicalised and would be of class E or B insulation with temperature rises not exceeding those stated in BS:2613-1957 or equivalent standards. Where motors are installed in open or dusty atmosphere, these shall be of the totally enclosed type with dust-tight cable boxes.

Controls of various motors will be grouped together into motor control centres. The various circuit elements will be selected to suit the rating and duty requirements of the driven equipment.

Cost of power

The total annual electricity bills for different alternatives have been calculated on the basis of flat rate energy charges of US $ 0.013 per kWh and are given in Table 5-7.

Table 5-7

ANNUAL ELECTRICITY BILL

Alternatives	Annual electricity bill $
Alt. 1	440 370
Alt. 2	1 081 586
Alt. 3	724 444
Alt. 4	489 300
Alt. 5	1 000 000

WATER SUPPLY SYSTEM

Existing system

The existing water supply system is a centralised recirculating system, the make-up water being drawn from the river Nile. The steelmelt shop draws its cooling water requirement from a ring network. The hot water from the shop is returned to the centralised recirculating system, cooled in cooling tower and recycled.

Water requirements

The estimated water requirements for the various alternatives are given in Table 5-8.

Table 5-8

ESTIMATED WATER REQUIREMENT

	Water in circulation m^3/hr	Make-up water m^3/hr
Alt. 1	1 020	62
Alt. 2	125	10
Alt. 3	200	15
Alt. 4	500	30
Alt. 5	125	10

It is understood that about 500 cu m/hr of water in circulation will be available from the existing water system. This will be capable of meeting the demand for Alternatives 2, 3, 4 and 5. However, in Alternative 1, the water requirement exceeds the quantity available from the existing system. It is, therefore, proposed to provide a separate recirculating system for the additional water requirement after utilising the available circulating water in the existing system. The make-up water for the proposed recirculating system will be catered from the existing system.

<u>Proposed water recirculating system for Alt. 1</u>

In the proposed water recirculating system, the soft water required for lance cooling, LD gas cooling units etc will be circulated through a heat exchanger and the losses in the system recuperated by soft water to be produced by a softening plant. The softening plant, sumps, pumps and the heat exchanger will be located in the steelmelt shop.

The industrial water for cooling the converter trunnion, heat exchanger etc will be supplied through a group of pumps. The return hot water will be collected in a hot well from where it will be pumped to a cooling tower, and then collected in a cold well and recirculated. Water for the scrubber will be supplied by a separate group of pumps from a sump. The contaminated return water will be treated to render it fit for reuse. The cooling tower, treatment plant, pumphouse with cold and hot wells and sumps etc will be located in the steelmelt shop area.

6 - IMPLEMENTATION SCHEDULE

The reconstruction work involved in the five alternatives is dealt with in this chapter. Tentative schedules for the implementation of each of the five alternatives have been developed.

Scope of reconstruction work

The reconstruction work can be divided into three broad areas, namely

i) additions to the existing Thomas shop

ii) dismantling works and modifications within the existing Thomas shop and

iii) installation of new facilities and modifications of the existing utilities outside the Thomas shop

Additions to the Thomas shop

The construction of the 170 m long and 22.5 m wide new casting aisle is a common feature of all the alternatives. The extension of the mixer and charging aisle by two bays of 10 m length on the north side is required for Alternatives 2 and 5 only. The foundations for the chimneys of the three LD converters are to be cast on the east side of the axis C.

6 - Implementation schedule (cont'd)

The present lime aisle will be extended by 20 m to the south in Alternative 4 and the necessary lime storage, grinding and conveying facilities will be installed for the OBM (Q-BOP) converters.

Limitations of the present construction

It is necessary to review the amenability of the existing structures and construction to modifications before assessing the work involved in the various alternatives.

Limitations imposed by existing construction features

Limitations of existing civil work

There are several design and construction features of the existing building which stand in the way of speedy implementation of the modifications required for reconstruction. The restraints imposed by these design and construction features are enumerated below:

i) Unlike common light weight roofing materials e.g. asbestos cement, galvanised corrugated steel, aluminium etc, dismantling of prestressed precast concrete roofs supported on steel purlins and trusses is time-consuming. Further, the precast slabs will get heavily damaged in the course of breaking of the in-situ concrete screeding overlying them and therefore, they can be salvaged only to a limited extent.

ii) The foundations of the Thomas converters and the column footings D5 to D8 are monolithic. Therefore, the breaking of concrete in the converter foundation or in the column footings cannot be carried out independently.

6 - Implementation schedule (cont'd)

iii) The two-storeyed general administration office building for the steelmelt shop is located only at a distance of about 26 m to the west of axis E. The existing small offset at the north-east corner of the office building is likely to interfere with the proposed addition of the new casting aisle and therefore may need to be removed.

iv) A large spread of 3.5 m column foundations on either side of the centre-line of axis E necessitates staggering of the foundations of the columns for the proposed casting aisle along axis H, by the side of axis E.

v) Generally, from safety considerations, a clearance of 200 m all round is specified around a drilled hole (in the ground) charged with blasting powder or dynamite. Alternatively, devices for controlled blasting with limited powder charge in the borehole and coverage of heavy materials over and around the hole are adopted when the available clearances are smaller say 20 m to 50 m, but this is attended by some risk. As adequate clearances are not available in the present case, it will not be possible to employ blasting techniques for removing old concrete works and foundations, and slower techniques of breaking the concrete have to be adopted.

The concrete in almost all the building and equipment foundations as well as superstructure parts such as platforms was cast between 1956 and 1958, at the time of initial construction. The age of these concrete works would be between 15 to 17 years when the dismantling operations for reconstruction of the Thomas shop would be started, say in 1974. It is a characteristic of concrete that its strength increases with age. Experiments carried out in different countries have shown that generally the crushing strength of concrete doubles over a period of twenty years from its standard strength at 28 days. This hardening of concrete with age is, therefore, likely to retard the pace of breaking concrete, and has to be taken into account while estimating the rate as well as the pace of breaking concrete.

Limitations of structural steelwork

A description of the features of structural steelwork of the existing building is given in Appendix 6-1. The converter aisle is a multi-storeyed steel-framed structure supporting the r.c. charging platform and the steel platforms at the three higher levels. Another multi-storeyed steel frame structure has been provided for the operation of two dolomite kilns. Other areas are covered by single-storeyed heavy industrial steelwork buildings. The major features of the structural steelwork of the steelmelt shop that render the task of modifications difficult are the following:

i) The columns are spaced at a close interval of 10 m which does not leave any siseable room for alterations in the layout.

ii) The details of the structures as fabricated and erected, and apparently also the designs, do not contain provision for parallel expansion of the existing shop.

6 - Implementation schedule (cont'd)

iii) The columns of the structures are of rivetted construction. If the columns are to be strengthened by addition of flange plates or other sections, the existing rivets have to be removed and replaced by driving rivets of longer shanks or by welding. This operation becomes quite involved and hence does not appear to be either feasible or desirable.

<u>Major modifications within steelmelt shop</u>

The major modifications required within the steelmelt shop area for the various alternatives are discussed below.

<u>Converter aisle</u>

For Alternatives 1, 3 and 5, the existing Thomas converters are to be replaced by new converters (LD, Thomas and side-blown). As this replacement requires the spacing of main columns to be increased from 10 m to 12/15 m, it would be necessary to dismantle the entire multi-platform converter building, including mono-rail, utility distribution network and building and equipment foundation, and to construct a new one in the same location. The charge weight of the converters in Alternative 4 will be raised from the present level of 17 tons to 22 tons. It is anticipated that the existing structural steelwork and the building and equipment foundations will be able to bear without modifications this additional load. The converter aisle construction remains intact under Alternative 2.

6 - Implementation schedule (cont'd)

Mixer aisle

As propping of the roof structure of the mixer aisle (covered by the precast concrete slabs) may be neither feasible nor desirable when the supporting roof girders along the axis D are dismantled along with the converter aisle structure, it will be necessary to dismantle the crane girders along axis D and the roof of the mixer aisle between column rows 3 and 8 for Alternatives 1, 3 and 5. The centres of existing columns along axis E and of new columns of the proposed casting aisle along axis H have been staggered to avoid interference of the new column foundations with the existing ones. However, this staggering is not feasible between columns 3 and 8 in the case of Alternatives 2 and 4, due to the existence of the steel transfer car tracks. The existing crane girders and columns on the E axis between these limits (excluding end columns) have to be dismantled and re-erected after breaking the existing foundations and casting new combined foundations for the affected columns along axes E and H. The roof girders supporting the mixer aisle roof will be temporarily supported on props during the dismantling of columns and their reinstatement.

Ladle repair aisle

The 16/3-ton crane traversing the ladle repair aisle and the crane girders have to be dismantled in all the alternatives. The column C-F will be dismantled and one crane girder will be added along axes C and D each to extend the travel of the 12.5-ton crane from the bottom-burning aisle between axes F and G in Alternatives 2 and 3. In the case of Alternative 5, the building between axes A and B will be dismantled together with the foundations, and a multi-platform building in structural steelwork will be constructed to house the two additional dolomite kilns.

Bottom-burning aisle

The bottom-burning ovens will be dismantled and an air-conditioned room for storage of tar-bonded dolomite bricks will be constructed in Alternatives 1 and 5.

Electric furnace aisle

The two electric furnaces will be dismantled as soon as the new converters are commissioned for regular production runs under Alternatives 1, 3 and 4. The foundation and ladle pits will be filled up. A track will be laid between rows 16 and 17 to transfer the scrap from the scrap yard to the mixer and charging aisle. The trolley of the 16/3-ton charging crane traversing this aisle will be dismantled and suitably modified for magnet attachment and providing DC connection to the magnet.

Pitside area

For all the alternatives, the casting pits for the Thomas steel will be filled up and the track for the steel casting car dismantled. A scrap transfer track will be laid parallel and close to the axis D in Alternatives 1, 3 and 4. One 25/5-ton ladle crane and the 10-ton stripper crane will be dismantled and re-installed in the new casting aisle. The casting pits for the electric arc furnaces will also be filled up in Alternatives 1, 3 and 4.

Lime aisle

The 3-ton mono-rail is to be dismantled in the Alternatives 1 and 4. In Alternative 1, necessary vibrating feeders will be fitted to lime bins and a system of conveyor and bucket elevator will be provided to transport the flumes to the LD converter overhead bins.

Modifications and additions outside steelmelt shop

The new auxiliary facilities including the buildings and their utility distribution network (wherever necessary) up to the steelmelt shop required to be installed outside the boundaries of the reconstructed steelmelt shop are:

i) oxygen plant and water treatment unit in Alternative 1

ii) lime kiln in Alternative 2

iii) oxygen plant and lime kiln in Alternative 3 and

iv) oxygen plant in Alternative 4.

No such additional facilities are required in Alternative 5. Besides these facilities, the existing connections of the railway lines to the Thomas shop have to be modified to suit

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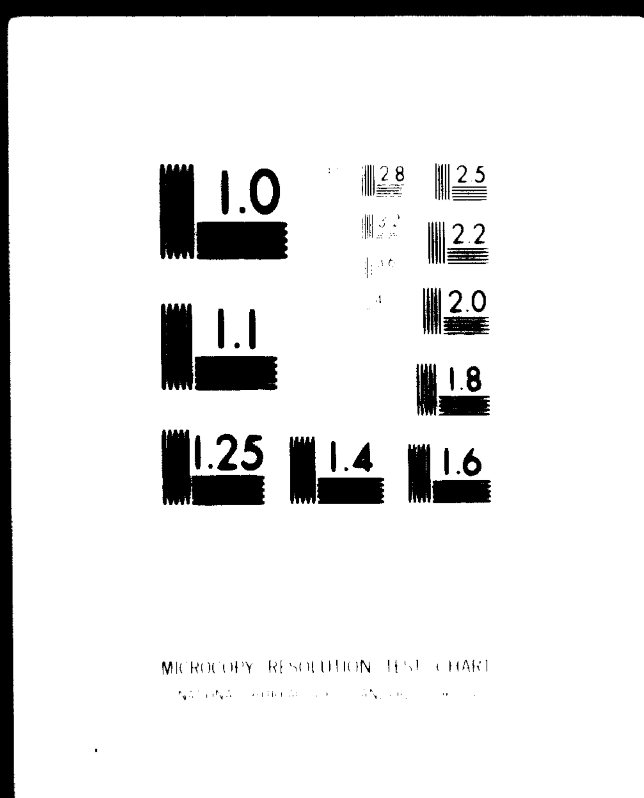

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the alignment of the new tracks and the shifted locations of the existing spurs.

Construction volume

Availability of the following data would have been of considerable help in making a reliable assessment of the quantum of work involved in dismantling and modifications:

i) a complete set of 'as-made' drawings of structural steelwork, reinforced concrete items and civil engineering works of the existing steelmelt shop;

ii) bill of quantities of the items enumerated above; and

iii) itemised breakdown of equipment weights.

The estimates of dismantling and modification works prepared in the absence of complete data are necessarily tentative, as they are based on the equipment arrangement drawings and other partial data.

The quantities of dismantling work thus estimated for the various alternatives are shown in Table 6-1. Alternatives 1, 3 and 5 require dismantling of 1,400 tons to 1,700 tons of structural steelwork, Thomas converter stacks and floor plates, and breaking of 1,750 cu m to 2,250 cu m of concrete. The corresponding quantities for Alternatives 2 and 4 are much smaller, being of the order of 130 tons of structurals and 300 cu m to 500 cu m of concrete.

6 - Implementation schedule (cont'd)

Table 6-1

ESTIMATED QUANTITIES OF DISMANTLING WORK

Item of work		Unit	Estimated quantity Alt. 1	Alt. 2	Alt. 3	Alt. 4	Alt. 5
Stationary equipment							
Mechanical parts / Refractories	..	ton	1 100	110	1 060	270	910
Overhead cranes and mono-rails	..	number	5	3	3	4	3
		ton	275	240	240	260	183
Structural steelwork	..	ton	1 450	130	1 470	130	1 700
Civil works							
Precast concrete slab roof	..	sq m	2 500	-	2 500	-	3 125
Brick walls	..	sq m	1 040	1 210	1 040	1 040	1 210
Glazing	..	sq m	4 000	3 200	3 200	4 000	4 000
Car tracks	..	meter	25	20	25	25	20
Reinforced concrete:							
Equipment foundations	..	cu m	1 115	40	1 045	300	1 130
Building foundations	..	cu m	375	260	870	225	860
Platforms	..	cu m	260	-	260	-	260
Sub-total - reinforced concrete			1 750	300	2 175	525	2 250

6 - Implementation schedule (cont'd)

The estimated quantities of civil works, structural steelwork and other items of reconstruction are shown in Table 6-2. About 6,500 cu m to 7,500 cu m of concrete has to be cast and over 2,000 tons of steel structures have to be fabricated for Alternatives 1, 3 and 5. The major reconstruction works under Alternatives 2 and 4 include fabrication of about 1,250 tons of steel structures and pouring of 4,000 cu m of concrete.

Whilst these aggregate quantities are useful in visualising and planning the overall reconstruction programme, what is really crucial from the viewpoint of speedy execution is the volume of work involved within the areas affected by shut-down during the shut-down period. The estimated quantities for this reconstruction work are shown in Table 6-3. It will be seen from the table that fairly large proportions of the total reconstruction work will have to be carried out during the shut-down period for Alternatives 1, 3 and 5 compared to Alternatives 2 and 4. About 60 per cent of the structural steelworks, 60 per cent of the equipment foundations, 33 per cent of pre-cast concrete roof slabs and over 25 per cent of the building foundations are required to be constructed/erected during the shut-down period for Alternatives 1, 2 and 5.

6 - Implementation schedule (cont'd)

Table 6-2

ESTIMATED QUANTITIES OF RECONSTRUCTION WORK a/

Item		Unit	Estimated quantity Alt. 1	Alt. 2	Alt. 3	Alt. 4	Alt. 5
CIVIL WORKS							
Reinforced concrete:							
Building foundations and plinth beams	..	cu m	4 395	3 495	3 605	3 400	4 385
Platforms	..	cu m	500	85	375	125	400
Equipment foundations	..	cu m	2 080	1 240	2 430	1 350	2 645
Total	..		6 975	4 820	6 410	4 875	7 430
Precast concrete roof slab	..	sq m	7 500	5 950	7 500	5 250	8 940
Brick masonry	..	sq m	1 165	1 665	1 165	1 375	1 600
Re-erection of glazing frame	..	sq m	4 000	3 200	3 200	4 000	4 000
Railway track	..	r m	300	280	280	300	280
STRUCTURAL STEELWORK							
Building structures:							
New	..	ton	2 050	1 250	2 300	1 150	2 750
Re-erected	..	ton	100	30	70	30	100
Floor plates	..	ton	300	50	250	65	240
Galvanised steel sheeting	..	sq m	2 300	-	-	-	-
Overhead cranes - re-erected	..	number	2	2	2	2	2
		ton	207	207	207	207	207

a/ These are the estimated quantities of reconstruction work within the battery limits of the Thomas shop only.

6 - Implementation schedule (cont'd)

Table 6-3

ESTIMATED RECONSTRUCTION WORK DURING SHUT-DOWN a/

Item		Unit	Estimated quantity Alt. 1	Alt. 2	Alt. 3	Alt. 4	Alt. 5
CIVIL WORKS							
Reinforced concrete:							
Building and platform column foundations	..	cu m	1 160 (26)	700 (20)	1 200 (33)	775 (23)	1 565 (36)
Charging platforms	..	cu m	500 (100)	85 (100)	375 (100)	125 (100)	400 (100)
Equipment foundations	..	cu m	1 180 (57)	- (0)	1 525 (63)	400 (40)	1 750 (66)
Total	..		2 840 (41)	785 (16)	3 100 (48)	1 300 (27)	3 715 (50)
Pre-cast concrete roof slabs	..	sq m	2 500 (33)	- (0)	2 500 (33)	- (0)	3 125 (35)
ERECTION							
Steel work	..	ton	1 250 (58)	280 (18)	1 480 (62)	250 (21)	1 800 (63)
Floor plates	..	ton	300 (100)	50 (100)	250 (100)	65 (100)	240 (100)
Cranes	..	number	2	2	2	2	2
		ton	207 (100)	207 (100)	207 (100)	207 (100)	207 (100)

a/ Figures in brackets indicate the proportion of the quantum of reconstruction work during the shut-down period to the total quantum of reconstruction work.

6 - Implementation schedule (cont'd)

Scheduling by critical path method

Development of critical path network

Reconstruction would affect the current production of the steelmelt shop in two ways. Firstly, it would lead to the shut-down of the Thomas converter operation during some phases of the construction activity within the shop, the duration of such shut-down depending upon the complexity of the modifications under the different alternatives. Secondly, the timing of the commencement of production from the reconstructed shop would depend on the overall implementation schedule. The interest on capital during the construction period would also increase in proportion to the length of the schedule and vary according to the phasing of the activities and the expenditure under the different alternatives. It is, therefore, necessary to ascertain the shut-down and reconstruction periods by critical path networks to enable a proper appraisal of the cost implications of the five alternatives and to provide guidelines for implementing the selected scheme. These networks for the five alternatives incorporating salient activity groups numbering 90 to 140 are presented in Drawings 519-6-1 to 519-6-5.

6 - Implementation schedule (cont'd)

Salient features of network

The total periods for engineering and reconstruction as well as the timing and duration of the shut-down derived from these networks are given in Table 6-4.

Table 6-4

SALIENT FEATURES OF RECONSTRUCTION SCHEDULE

Construction feature	Months from the date of 'go-ahead' signal				
	Alt. 1	Alt. 2	Alt. 3	Alt. 4	Alt. 5
Total engineering and reconstruction period	36	26	35	27	36
Shut-down begins after	12	23	12	23	12
Shut-down duration (total months)	24	3	23	4	24

Alternatives 2 and 4 have short shut-down periods of 3 and 4 months respectively, while Alternatives 1, 3 and 5 would require much longer shut-down of 23 to 24 months, because of the complete dismantling of equipment and multi-storeyed structures as well as foundations of the converter aisle and construction and erection of new facilities. Dismantling activities alone will account for a little over one-fourth of this total shut-down period. The overall construction period for Alternatives 1, 3 and 5 is estimated at about 36 months as against the corresponding periods of 26 and 27 months for Alternatives 2 and 4 respectively. These periods are reckoned from the date of the 'go-ahead' signal by HADISOLB after the selection of an alternative for implementation, the finalisation of financing arrangements for the project and the appointment of Consulting Engineers. It is expected that these arrangements would be finalised by HADISOLB by end of 1972 and the 'go-ahead' signal is assumed to be given by 1st January 1973.

<u>Critical paths for overall implementation</u>

The groups of activities along the critical paths for the overall implementation schedule with the different alternatives identified from the networks are as follows.

<u>Alts. 1, 2 and 5</u>: Preparation of specification for and issue of global enquiries for the converters; receipt of tenders, negotiations with equipment suppliers and placement of orders; receipt of design data from the selected equipment suppliers for civil and structural drawings; dismantling of the existing converter aisle; reconstruction of a new converter aisle; and erection of converters and auxiliaries and trial operation runs before commissioning.

<u>Alts. 2 and 4</u>: Construction of the new casting aisle and erection of equipment in this aisle; and for Alternative 4, preparation of specifications, issue of enquiries, placement of orders, delivery and erection of oxygen plant also.

In order to ensure that the new construction can be started without delay as soon as the existing structures and foundations are dismantled in Alternatives 1, 3 and 5, it

6 - Implementation schedule (cont'd)

would be advisable to commence dismantling of the existing convertor aisle only when the requisite data for preparation of civil and structural steelwork drawings are available from the suppliers of new equipment. The preparation of new drawings could be completed during the period of dismantling of the convertor aisle.

A saving of about one month in the erection of the steelmaking equipment is estimated in case of Alternative 3 compared to Alternatives 1 and 5, as Thomas convertors are relatively simpler to erect compared to LD convertors and side-blown convertors.

Critical paths for the plant shut-down

The critical path for the shut-down of the Thomas convertors for Alternatives 1, 3 and 5 passes through the activities for the dismantling and reconstruction of the foundations and the building and erection of new equipment in the convertor aisle. This path, therefore, coincides with the one for the overall implementation.

Two critical paths are envisaged for the shut-down periods for Alternatives 2 and 4. The twin activities of dismantling the 25/5-ton ladle and 10-ton stripper overhead travelling cranes in the mixer and charging aisle and their re-erection in the casting aisle are critical for determining

6 - Implementation schedule (cont'd)

the shut-down duration in these two alternatives. The civil and structural works comprising dismantling of 3 to 4 main columns and 4 to 5 crane girders along the axis E, breaking foundations of these columns, casting new combined foundation for columns E and H axes at the same locations and re-erection of dismantled columns and crane girders constitute another parallel critical path for these two alternatives.

Equipment delivery periods

Delivery periods for the supply and shipment of major equipment from the date of placement of order are estimated as follows:

	Equipment	Period of delivery to site from placement of order months	Available float months
Alt. 1, 3 and 5	LD, Thomas and side-blown converters	18	4
Alt. 4	OBM facilities	5	12
Alt. 1, 3 and 4	Oxygen plant	14	3 (Alt. 1 and 3) Nil (Alt.4)
Alt. 4	Flux grinding plant for OBM converters	10	5

It is expected that the bulk of the imported equipment will be purchased from European suppliers and therefore an allowance of two months for ocean and inland transport from

6 - Implementation schedule (cont'd)

the date of shipment is considered adequate. In the case of Alternative 4, which envisages the adoption of the new steelmaking technique by OBM process, a six-month period for negotiating know-how and equipment supplies is envisaged.

It may be worthwhile to note that a large float is available in the placement of order and delivery of OBM facilities, as the modifications to the existing Thomas convertors for adopting OBM process can only be taken up after the work in the new casting aisle is sufficiently advanced when the shut-down operation is undertaken. It would, however, be advisable to carry out negotiations with the OBM equipment supplier at an early stage as indicated in the network, as this being a new process, would warrant more elaborate scrutiny.

Adjustments for lead and lag periods

Appropriate adjustments in the time-estimates for individual activities are provided in the form of lead and lag timings where major successive activities overlap. For example, a lead of three months for fabrication over the erection of structural steelwork has been provided, assuming that the erection work can be started three months after the commencement of fabrication. Similarly, a time lag of one month for the completion of the erection of structural steelwork beyond the completion of its fabrication has been

6 - Implementation schedule (cont'd)

provided. In the case of some major equipment like convertors, a lead of about two months for the receipt of materials at the plant site over the shipment of equipment from the foreign suppliers and for the commencement of erection work over the receipt of materials at site has been provided. This lead has been increased to 4 months for the oxygen plant.

Casting aisle construction deferred

As considerable slack is available in the construction of the casting aisle for Alternatives 1, 3 and 5, its construction has been deferred to make its commissioning coincide with that of the main equipment in the convertor aisle, with a view to conserve the capital expenditure and minimise interest charges on capital during construction.

Cranes

As dismantling is the reverse process of construction and installation, some of the resources, tools and tackle employed for construction may be employed for dismantling operations. For instance, the erection of equipment in the new buildings is expedited with the help of overhead travelling crane installed ahead of it. Conversely, dismantling of equipment can be crashed with proper utilisation of existing cranes and postponing dismantling of cranes and crane girders till the completion of equipment dismantling. In fact, instances of erecting a third crane in the same

6 - Implementation schedule (cont'd)

provided. In the case of some major equipment like convertors, a lead of about two months for the receipt of materials at the plant site over the shipment of equipment from the foreign suppliers and for the commencement of erection work over the receipt of materials at site has been provided. This lead has been increased to 4 months for the oxygen plant.

Casting aisle construction deferred

As considerable slack is available in the construction of the casting aisle for Alternatives 1, 3 and 5, its construction has been deferred to make its commissioning coincide with that of the main equipment in the converter aisle, with a view to conserve the capital expenditure and minimise interest charges on capital during construction.

Cranes

As dismantling is the reverse process of construction and installation, some of the resources, tools and tackle employed for construction may be employed for dismantling operations. For instance, the erection of equipment in the new buildings is expedited with the help of overhead travelling crane installed ahead of it. Conversely, dismantling of equipment can be crashed with proper utilisation of existing cranes and postponing dismantling of cranes and crane girders till the completion of equipment dismantling. In fact, instances of erecting a third crane in the same aisle with the help of two existing cranes without any substantial loss of production are not uncommon in the steel plants. Possibilities of reducing the shut-down period in the case of alternatives 2 and 4 for dismantling cranes in the mixer and charging aisle and re-erecting them in the new casting aisle by this technique can, therefore, be explored at the engineering stage.

Crashing cost

Though the direct cost of dismalting equipment with the exception of the stripper crane would constitute only a small fraction of the total cost of reconstruction, its impact on the duration of shut-down of plant operations as well as on the overall reconstruction programme is significant. The relative cost figures of dismantling at normal construction rates and those of the shut-down period of corresponding duration for the five alternatives deduced from the project cost estimates compiled in Chapter 7 are shown in Table 6-5.

It will be noted from Table 6-5 that the ratio of shut-down costs during the dismantling period to the direct cost of dismantling approximates to unity for Alternative 4 and is higher than unity for the other alternatives. The shut-down cost and consequently this ratio would work out still higher

6 - Implementation schedule (cont'd)

Table 6-5

COMPARATIVE COSTS OF DISMANTLING AND SHUT-DOWN

	Unit	Alt. 1	Alt.2	Alt.3	Alt.4	Alt.5
Dismantling costs a/ ..	'000 $	204	51	212	55	222
Shut-down period for dismantling ..	months	7	1.25	7	1.25	7
Shut-down costs during dismantling period ..	'000 $	274	54	305	49	274
Ratio of shut-down costs to dismantling costs ..		1.34	1.06	1.43	0.69	1.23

a/ Without taking credit for salvaged materials.

if the interest charges on the fixed investment on the steel-melt shop and reconstruction project as well as the losses that may have to be incurred due to consequential disruption in the other units of the integrated steel plant are taken into account. It would, therefore, be a prudent course at the engineering stage to optimise the combination of shut-down costs and direct dismantling costs by incurring crashing costs for shortening the dismantling period.

Construction materials

Bulk indents of structural sections

Heavy joists and channels above the depth of 26 cm, crane girder rails of heavy profiles as well as a few other sections of structural steel are not rolled indigenously at present and hence will have to be imported well ahead of the

6 - Implementation schedule (cont'd)

fabrication of the structural steelwork. Also, the indent for the requisite sections on the local rolling mills has to be placed well in advance to enable the rolling mills to pool together orders of economic batch sizes. It will, therefore, be necessary to place bulk indents for structural steel within 5 to 6 months from the date of 'go-ahead' signal, in anticipation of the possible requirements of sections on finalisation of the building designs.

Setting up of inventory

With a view to minimise the shut-down period and to expedite reconstruction, it will be necessary to build up an inventory of items which may be required for replacement during the re-erection of dismantled equipment and structures. Typical examples are bolts, nuts and other fasteners for structural steelwork and bearings and rivets for overhead travelling cranes and electrodes for welding operations.

A typical list of replacement parts whose stocks have to be built up before the commencement of dismantling and shifting of the cranes from the charging aisle to the new casting aisle will include:

i) bearings for cross travel and long travel wheels
ii) thrust bearings for the main and auxiliary hooks
iii) bearings for all motions to the gear boxes

6 - Implementation schedule (cont'd)

iv) brake solenoid coils

v) brake shoe lining and

vi) fixed and moving contacts of contractors

Synchronising upstream and downstream production units

As the steelmelt shop is an intermediate production unit in the integrated steel plant, advance planning would be necessary to minimise disruptions in the operations of other upstream and downstream units when the Thomas convertors are shut-down for reconstruction. Some important aspects which would require adequate advance planning by HADISOLB are enumerated below:

i) Supply of small quantities of calcined lime and dolomite required for electric arc furnaces during the shut-down period of the Thomas convertors has to be ensured from the external sources.

ii) Arrangements have to be made for casting the hot metal into pigs, thus converting the surplus hot metal during the transition period into saleable pigs after studying its economics.

iii) Arrangements for procuring ingots and blooms/billets to cover up shortfalls in ingot supplies from the steelmelt shop during transition period have to be finalised.

The increase in the ingot production capacity of the steelmelt shop from 250,000 tons per annum to 380,000 tons per annum on completion of reconstruction would need to be

6 - Implementation schedule (cont'd)

matched with the corresponding increase in the capacity of production and auxiliary facilities in the upstream units, namely blast furnaces, sintering plant and coke ovens as well as inter-unit material transportation system for the upstream units, as well as downstream units, namely the blooming and rolling mills. Measures for balancing the capacities of those facilities have to be undertaken by HADISOLB simultaneously with the steelmelt shop reconstruction. This would ensure supply of hot metal and scrap to the steelmelt shop in the requisite quantities and the off-take of the entire ingot production by the blooming mills.

7 - CAPITAL COST ESTIMATES

Major items of cost

Cost estimates tentative

The capital cost estimates for the reconstruction of the steelmelt shop are presented in this chapter. It needs to be emphasised that the estimates are only indicative of the order of magnitude for the purpose of relative economic evaluation of the various alternative schemes. At the time of implementation, detailed study will have to be made on the selected alternative to define the costs more precisely.

Cost components

The estimates include:

i) cost of dismantling existing items not required in the reconstructed facilities,

ii) cost of modifications and reconstruction of existing facilities proposed to be retained,

iii) cost of new facilities,

iv) losses arising out of stoppage of production due to shut-down of facilities during the reconstruction period,

v) cost of engineering services,

vi) contingencies and

vii) interest charges on capital required for reconstruction during the period of revamping of the Thomas shop and auxiliary facilities.

7 - Capital cost estimates (cont'd)

Besides the above, expenses of a capital nature have also to be incurred on progressive replacement of some of the retained old equipment after the steelmelt shop is reconstructed and commissioned.

Cost of dismantling

Rates for dismantling

The rates for dismantling assumed for the purpose of arriving at the total cost of dismantling of facilities in the various alternatives are given in Table 7-1.

Table 7-1

RATES FOR DISMANTLING WORKS

Dismantled item	Unit	Rate $
Stationary equipment:		
Mechanical and electrical parts ..	ton	70.00
Refractories	ton	15.00
Structural steelwork, floor plates and converter stacks ..	ton	58.25
Breaking reinforced concrete in the foundations and building works a/ ..	cu m	11.60
Breaking pre-cast concrete roof slab ..	sq m	0.60
Half-brick unplastered walls ..	sq m	1.75
Tracks	metre	19.00

a/ Estimated at four times the labour cost of pouring concrete.

The rates for dismantling other items have been estimated on the following basis:

i) The cost of dismantling existing cranes has been assumed at 4 per cent of the estimated replacement cost of cranes at current prices.

7 - Capital cost estimates (cont'd)

ii) The cost of dismantling distribution network for utilities and power supply system has been provided at the rate of 20 per cent of the estimated dismantling cost of the related equipment items.

Cost estimates for dismantling

The cost estimates of dismantling works for each of the five alternatives are given in Table 7-2. These estimates range from $ 51,000 to $ 222,000 for different alternatives.

Table 7-2

COST ESTIMATE OF DISMANTLING WORK
(in '000 $)

Item of work	Alt.1	Alt.2	Alt.3	Alt.4	Alt.5
Structural steelwork ..	85	8	86	8	99
Civil work					
Pre-cast concrete roof ..	2	-	2	-	2
Brick walls and glazing frames	7	6	6	7	7
Reinforced concrete in buildings, equipment foundations and platforms	20	3	25	6	26
Sundry items of civil and structural works and tracks	23	4	24	5	27
Sub-total of civil and structural steelwork	137	21	143	26	161
Equipment					
Mechanical and electrical equipment Refractories	51	11	48	11	43
Overhead cranes ..	10	15	15	15	12
Electrical system and utilities ..	6	4	6	3	6
Sub-total of equipment	67	30	69	29	61
Total	204	51	212	55	222

7 - Capital cost estimates (cont'd)

Salvage value of discarded facilities

Basis for computing salvage value

The salvage value of the discarded equipment and buildings is calculated at the following rates:

i) 50 per cent of the written down book value of equipment such as cranes, electric arc furnaces and ladles assuming 5 per cent depreciation per annum of the value of original installation,

ii) $ 58.25 per ton of the estimated weight of other discarded equipment, being the current price of steelmelting scrap and

iii) $ 72.8 per ton of the estimated weight of the dismantled structural steelwork in the buildings, assuming that 50 per cent of this scrap could be disposed off as re-rollable scrap at $ 87.37 per ton and the balance 50 per cent as melting scrap.

It may not be possible to use the reinforcing steel bars recovered from the broken concrete and therefore no credit is allowed for their resale or melting. The salvage value is computed on this basis in Appendix 7-1 for the various alternatives and summarised in Table 7-3.

Table 7-3

SALVAGE VALUE OF DISCARDED FACILITIES

Discarded items		Salvage value '000 $				
		Alt.1	Alt.2	Alt.3	Alt.4	Alt.5
Discarded equipment:						
Re-usable	..	77	-	69	74	18
Waste scrap value	..	30	2	30	3	30
Discarded structures	..	98	2	10	7	117
Total	..	205	4	109	84	165

7 - Capital cost estimates (cont'd)

Net dismantling costs

The net cost estimate of dismantling work after allowing credit for this salvage value is shown in Table 7-4. It will be seen from this table that the credit for salvage value exceeds the estimated cost of dismantling for Alternatives 1 and 4, mainly due to the higher salvage value, expected from the electric furnaces and their auxiliaries.

Table 7-4

NET COST ESTIMATE OF DISMANTLING WORK
(in '000 $)

	Alt.1	Alt.2	Alt.3	Alt.4	Alt.5
Cost estimate of dismantling work	204	51	212	55	222
Less:					
Salvage value	205	4	109	84	165
Net cost	-1	47	103	-29	57

Cost of modification and reconstruction of existing facilities

The estimated cost of modification and reconstruction of existing facilities includes the cost of reconstruction of all structural steel and civil engineering items, re-laying of bogie and railway tracks and re-erection of equipment at new locations.

Re-use of dismantled structures

In making these estimates, it is assumed that precast prestressed concrete roof slabs dismantled from the existing structures will not be suitable for re-use. Where a part of the steel structure is required to be dismantled along with the other supporting structures and re-erected, its use for reconstruction has been considered. Though it may be possible to salvage a part of the other dismantled steel structures and use them after refabrication, the exact quantity that could be so used will be ascertained only at the engineering stage. For assembling and re-erecting old structures, it will be necessary to use certain new materials like bolts, nuts, splicing materials etc. No credits have been allowed for the possible re-use of dismantled structures nor is any provision made for expenses on these minor items. It is expected that credits on the former account will tend to offset the small expenditure on these minor items.

Rate for re-erection

The rate for re-erection of dismantled overhead travelling cranes is taken as 8 per cent of the ex-works replacement cost at current prices. Besides, a provision at a rate of 2 per cent of this value has been made for certain parts like bearings, fasteners etc which might be required during re-erection.

Construction rates

The construction rates for civil engineering works are assumed on the basis of rates quoted by the local contractors and these are given in Table 7-5.

7 - Capital cost estimates (cont'd)

Table 7-5

RATES OF CONSTRUCTION WORK

Item of work		Unit	Rate $
BUILDING STEELWORK			
Supply, fabrication and erection of structural steelwork	..	ton	420.00
Supply and erection of C.I. floor plates	..	ton	350.00
Supply and fixing of C.G.I. sheets	..	sq m	4.66
Erection of dismantled steelwork	..	ton	58.25
Re-erection of glazing frames and glass and parts supply of 6 mm thick wire glass	..	sq m	7.60
CONCRETE WORKS			
Concrete of 150 kg/cm^2 ultimate strength for building and equipment foundations including excavation, reinforcing steel and shuttering	..	cu m	56.00
Precast roof slabs of concrete of 200 kg/cm^2 ultimate strength - supply and screening	..	sq m	7.10
- erection	..	sq m	1.50
Double tar-felt layer water-proofing of pre-cast concrete roof slabs	..	sq m	1.75
Half-brick thick masonry wall	..	sq m	1.25
Laying of standard 1.45 metre gauge track	..	rm	44.00

Twenty per cent of the estimated cost of structural steelwork will require expenditure in foreign currency as heavy joists and channels above 26 cm depth and a few other sections will have to be imported for fabrication.

Cost estimate of reconstruction

Cost estimates of reconstruction works developed on the above basis for the various alternatives are given in Table 7-6 on next page. The estimated costs for modifications and reconstruction under Alternatives 2 and 4 are each of the order of $ 1.2 million while for the other alternatives, they are higher by about $ 0.7 million.

7 - Capital cost estimates (cont'd)

Table 7-6

COST ESTIMATE OF RECONSTRUCTION WORK

Items		Estimated reconstruction cost '000 £				
		Alt. 1	Alt. 2	Alt. 3	Alt. 4	Alt. 5
RECONSTRUCTION WITHIN STEELMELT SHOP						
Civil works						
Reinforced concrete:						
Building foundations and plinth beams	..	246	196	202	190	246
Platforms ..	..	28	5	21	7	22
Equipment foundation ..	..	116	69	136	76	148
Sub-total of reinforced concrete	..	390	270	359	273	416
Pre-cast concrete slabs	..	78	62	78	54	93
Brick masonry ..	..	1	2	1	2	2
Glazing frame ..	..	31	24	24	31	30
Structural steelwork						
Building structures:						
New ..	..	861	525	966	483	1 155
Re-erected ..	..	6	2	4	2	6
Floor plates ..	..	105	18	88	23	84
Galvanised steel sheets..	..	11	-	-	-	-
Building accessories like gutters, louvres etc		49	27	53	25	62
Sub-total of civil work and structural steelwork	..	1 532	930	1 573	892	1 848
Railway tracks 1 in 8½ railway turnouts	..	13	12	12	13	12
Re-erection of overhead cranes	..	64	41	64	64	41
RECONSTRUCTION OUTSIDE STEELMELT SHOP						
Lime kiln, oxygen plant and other services and utilities ..	..	204	244	259	198	-
Railway track ..	..	6	4	6	6	6
Total ..	..	1 819	1 231	1 914	1 174	1 907

Cost of new facilities

Estimate of equipment cost

As the metal working industry is fairly advanced in the Arab Republic of Egypt (ARE), it is assumed that most of the simple equipment items as well as fabricated metal parts and components of relatively simpler designs for the main production equipment will be available from indigenous sources and the rest imported.

The cost estimates for the major items of imported equipment are generally derived from the prevailing prices for similar equipment in the European market and from the information available with the Consulting Engineers. The equipment costs cover the cost of mechanical and electrical items as well as refractories.

Freight, insurance and inland transport

The incidence of freight and insurance charges is estimated at 10 per cent of the estimated f.o.b. value of imported equipment. The transport cost from Alexandria port to Helwan is currently of the order of $ 3.9 per ton which roughly works out to 3.5 per cent of the estimated c.i.f. value of equipment. The incidence of inland transport cost of local equipment is estimated at a slightly lower figure of 3 per cent of the estimated ex-works cost. It is assumed that no taxes or duties will be leviable on the local items of manufacture.

Customs duty

The prevalent rates of import duty on major items of imported equipment are shown in Appendix 7-2. The average rate of import duty on equipment is of the order of 17 per

7 - Capital cost estimates (cont'd)

cent except for the following items where import duties are considerably higher.

Item	Import duty % of c.i.f. value
Cranes ..	35
Electrical equipment other than transformers	115
Equipment for water and other utilities ..	25

Erection cost

The rates for erection of typical equipment items are given in Appendix 7-3. The rates vary from about $ 90 per ton for single piece equipment to about $ 510 for internal pipework. The incidence of erection cost therefore would vary from 6 per cent for massive equipment to about 25 per cent for light weight items like pipes. However, a uniform rate of 10 per cent of the c.i.f. value of imported equipment and ex-works value of local equipment has been assumed for roughly estimating the erection costs. These estimates are made on the assumption that the tools, tackle and cranes required for erection will be provided by the erection contractors.

Cost estimate of new facilities

The estimated costs of supply and erection of new equipment and utilities together with the foreign exchange requirements for the five alternatives are given in Table 7-7. Alternative 2 will require the lowest investment of about $ 2.8 million on new facilities, as only balancing items are to be provided. Alternative 1 would require the highest capital investment of about $ 12.6 million, a major part of this outlay being on the LD steelmaking equipment, gas cleaning plant and oxygen plant.

7 - Capital cost estimates (cont'd)

Table 7-7

COST OF SUPPLY AND ERECTION OF NEW EQUIPMENT AND UTILITIES
(in '000 $)

	Alt. 1		Alt. 2		Alt. 3		Alt. 4		Alt. 5	
	Total	Foreign currency	Total	Foreign currency	Total	Foreign currency	Total	Foreign currency	Total	Foreign currency
Steelmaking equipment and accessories ..	5 320	1 357	350	270	641	495	175	135	704	543
Auxiliary sections	418	121	778	364	657	281	452	151	1 268	716
Material handling equipment ..	713	55	569	-	638	10	569	10	570	-
Utilities ..	5 716	2 779	877	310	2 474	1 379	4 663	2 789	1 171	438
Miscellaneous items	455	-	230	-	455	-	455	-	455	-
Total ..	12 622	4 312	2 804	944	4 865	2 165	6 314	3 085	4 168	1 697

7 - Capital cost estimates (cont'd)

Engineering services

Cost of engineering services

A provision of 8 per cent of the estimated cost of the supply and erection of new facilities and dismantling and reconstruction works has been made for the construction supervision and engineering services. Half of the expenditure under this head is assumed to be in foreign currency under all the alternatives except Alternative 2 where it has been assumed to be lower at 20 per cent, as bulk of the existing equipment is being retained. It has been assumed that the administration of the project will be looked after by the present set up of HADISOLB and no additional administration expenses need to be provided.

Shut-down of plant operations

Production loss due to shut-down

From the date of 'go-ahead' decision for the reconstruction of the shop, the existing shop will continue to produce as at present 200,000 tons of ingots from the Thomas converters and 50,000 tons of ingots from the two arc furnaces during the first year under all the alternatives. The reconstruction of the Thomas shop would call for the shut-down of the Thomas converter section during the second and third years, the duration of the shut-down depending on the extent of modification and reconstruction work involved under the various alternatives. The estimated loss of production during the shut-down period for the five alternatives is shown in Table 7-8.

7 - Capital cost estimates (cont'd)

Table 7-8

PHYSICAL PRODUCTION LOSSES DURING THE SHUT-DOWN PERIOD

	Unit	Alt.1	Alt.2	Alt.3	Alt.4	Alt.5
Shut-down duration	month	24	3	23	4	24
Production loss	'000 tons	400	50	384	67	400

Electric furnaces operate

During the shut-down of the Thomas converter section, the electric arc furnaces would continue to be in operation. As regards the upstream and downstream production units, namely the blast furnaces and rolling mills, it was indicated by HADISOLB during discussions that they would plan to keep them in operation by making arrangements for the sale of pig iron produced from the blast furnaces and for procurement of ingots and blooms/billets for the rolling mills. Accordingly, only the losses arising directly out of the shut-down of the Thomas converter section and related facilities have been accounted for. The fertiliser plant which processes the Thomas slag would be permanently closed down in Alternatives 1, 4 and 5 where low phosphorus hot metal is refined. Therefore, the shut-down losses of the fertiliser plant have been reckoned only for Alternatives 2 and 3.

Continuing cash expenses during shut-down

The cash surplus that would have been generated otherwise in the Thomas converter section remained to be in operation plus the continuing cash expenditure on the plant units during the shut-down period, can be considered to

7 - Capital cost estimates (cont'd)

constitute the financial losses due to the shut-down of plant operations. Assuming that the Thomas steel ingots are transferred from the steelmelt shop to the blooming mill at cost price, no cash surplus is considered to be available from the operations of the Thomas converters. The continuing cash expenses of the plant units needing shut-down are estimated at $ 0.522 million per year on the basis of the cost data for the year 1970/71 as shown in Appendix 7-4 and summarised in Table 7-9. The cost of shut-down for Alternatives 1, 4 and 5 would be less by about $ 52,000 per year due to exclusion of the slag fertilizer plant.

Table 7-9

CONTINUING CASH EXPENSES UNDER SHUT-DOWN CONDITIONS

Section	Wages $/yr	Insurance and overheads $/yr	Repair and maintenance expenses a/ $/yr	Total $/yr
Full expenses				
Thomas convertor	156 333	84 348	28 618	269 299
Mixer section	12 908	7 249	6 520	26 677
Lime kiln	10 908	17 310	2 984	31 202
Dolomite preparation	88 626	44 819	9 670	143 115
Slag fertiliser plant	31 042	16 888	3 766	51 696
Total with fort. plant	299 817	170 614	51 558	521 989
Total excl fertiliser plant	268 775	153 726	47 792	470 293

a/ Assumed at 10 per cent of the total cost of repair and maintenance work done in the repair workshops.

7 - Capital cost estimates (cont'd)

The above shut-down costs have been calculated on the assumption that the labour force would continue to be paid full salaries (excluding overtime dues and incentives) during the shut-down period and only a small fraction of this regular force would be deployed on the reconstruction work.

Losses due to converter shut-down

Table 7-10 shows the losses arising from the shut-down of the Thomas converter operations under the five different alternatives during the second year and third year of the 'go-ahead' signal.

Table 7-10

LOSSES DUE TO SHUT-DOWN OF THOMAS CONVERTER OPERATIONS

		Unit	Alt.1	Alt.2	Alt.3	Alt.4	Alt.5
Shut-down cost	..	'000 $/ month	39.2	43.50	43.50	39.2	39.2
Second year							
Shut-down time	..	months	12	1	12	1	12
Shut-down cost	..	'000 $	470	44	522	39	470
Third year							
Shut-down time	..	months	12	2	11	3	12
Shut-down cost	..	'000 $	470	87	479	118	470
Total time	..	months	24	3	23	4	24
Total cost	..	'000 $	940	131	1 001	157	940

Contingencies

Contingencies have been allowed for at 5 per cent of the estimated reconstruction cost including shut-down losses.

Aggregate capital cost estimate

Total cost estimates

The various components of the capital cost for the five alternatives have been collated in Appendix 7-5 and summarised in Table 7-11.

7 - Capital cost estimates (cont'd)

Table 7-11

TOTAL CAPITAL COST ESTIMATE FOR RECONSTRUCTION
(in '000 $)

	Alt. 1		Alt. 2		Alt. 3		Alt. 4		Alt. 5	
	Total	Foreign currency	Total	Foreign currency	Total	Foreign currency	Total	Foreign currency	Total	Foreign currency
1. New equipment and utilities:										
i) Supply ..	11 273	4 298	2 546	944	4 454	2 165	5 508	3 085	3 823	1 697
ii) Erection ..	1 349	-	258	-	411	-	806	-	345	-
2. Dismantling ..	-1	-	47	-	103	-	-29	-	57	-
3. Reconstruction work	1 819	237	1 231	160	1 895	268	1 174	140	1 907	270
4. Construction supervision and engineering services ..	1 155	578	327	65	549	275	597	299	491	246
5. Shut-down cost ..	940	-	131	-	1 001	-	157	-	940	-
6. Contingencies ..	832	256	227	58	421	135	411	176	378	111
Total ..	17 367	5 369	4 767	1 227	8 834	2 843	8 624	3 700	7 941	2 324

7 - Capital cost estimates (cont'd)

Capital cost highest for Alternative 1

The alternatives arranged in the ascending order of their capital costs are 2, 5, 4, 3 and 1. The requirement of capital for Alternative 1 is almost double that of Alternative 4, which is the third highest. The foreign exchange component ranges from 25 per cent to 40 per cent for the various alternatives excluding the shut-down costs.

Interest on capital during reconstruction

Phasing of expenditure

The phasing of the capital expenditure for the different alternatives is given in Table 7-12.

Table 7-12

ESTIMATED PHASING OF CAPITAL EXPENDITURE[a]
(in '000 $)

Half-year period from 'go-ahead' signal		Alt. 1	Alt. 2	Alt. 3	Alt. 4	Alt. 5
1	..	303	454	144	840	129
2	..	1 174	631	461	960	403
3	..	741	2 231	810	4 124	739
4	..	9 447	1 077	4 285	2 104	3 780
5	..	4 212	374	2 214	596	2 025
6	..	1 490	-	920	-	865
Total	..	17 367	4 767	8 834	8 624	7 941

a/ Including continuing expenses during the shut-down period.

7 - Capital cost estimates (cont'd)

Interest charges

The interest charges on borrowings during construction are computed on the basis of the phasing shown in Table 7-12. It is assumed that the funds required for a six-month period will be available at the beginning of the relevant period and that interest will be charged at 6.5 per cent per annum, the prevailing rate on long-term bank borrowings in the country. The interest charges thus calculated for the various alternatives are shown in Appendix 7-6 and the total interest charges on borrowings during construction are shown in Table 7-13 below:

Table 7-13

INTEREST ON CAPITAL DURING CONSTRUCTION
(in '000 $)

Half-year period		Alt. 1	Alt. 2	Alt. 3	Alt. 4	Alt. 5
1	..	10	15	5	27	4
2	..	48	36	20	59	17
3	..	74	109	47	195	42
4	..	383	148	188	270	166
5	..	533	-	266	-	237
6	..	598	-	304	-	273
Total	..	1 646	308	830	551	739

7 - Capital cost estimates (cont'd)

Progressive replacement of retained equipment

In addition to the above capital cost expenses during the reconstruction of the steelmelt shop, periodic replacement costs have to be incurred at the end of the economic life of the existing equipment that will be retained after reconstruction. The estimates of capital expenses on replacement of retained facilities are discussed below.

1974 replacement cost of retained equipment

Escalation trends in the replacement costs of general machinery items and steel works installation from the year 1953 to 1969 are shown in Appendix 7-7 and summarised in Table 7-14.

Table 7-14

ESCALATION TRENDS IN REPLACEMENT COSTS OF STEELWORKS

Time interval	Increase in replacement costs of steelworks					
	General machinery		UK steelworks		Indian steelworks	
	Cumulative %	Compounded annually %	Cumulative %	Compounded annually %	Cumulative %	Compounded annually %
1954 to 1958	13.24	2.55	30.6	5.5	33.0	5.87
1959 to 1963	6.38	1.25	14.8	2.81	14.0	2.62
1964 to 1968	10.00	1.88	18.2	3.4	17.9	3.37
1954 to 1968	32.53	1.90	76.8	3.87	78.8	3.90
1957 to 1969a/	30.23	2.05	54.2	3.38	...	...

a/ This period is shown as the construction of the Helwan steel plant was commenced in 1956 and data on escalation trend is available till 1969.

7 - Capital cost estimates (cont'd)

Replacement requirements

The replacement requirements of equipment in a new steel plant are generally of a minor nature during the first 15 years or so of operation. However, the frequency of breakdown of some items of equipment progressively increases thereafter, necessitating a continuous replacement programme to ensure uninterrupted plant operations. Experience shows that such replacement cost ranges approximately from 2 per cent to 3 per cent of the total equipment cost as installed.

For the Thomas shop facilities to be retained, the replacement process has been assumed to commence from the year 1974/75. The estimated capital cost of replacement per year at the rate of 2 per cent of the value of retained equipment from the year 1975 onwards is shown in Table 7-15.

7 - Capital cost estimates (cont'd)

Table 7-15

ANNUAL CAPITAL EXPENSES ON EQUIPMENT REPLACEMENTS
(in '000 $)

	Alt. 1	Alt. 2	Alt. 3	Alt. 4	Alt. 5
Estimated value of retained equipment at 1974 price ..	2 965	8 339	5 456	4 337	6 001
Estimated value of equipment replacement per year:					
i) at 1974 price ..	59.3	166.8	109.1	86.7	120.0
ii) equivalent annual price escalation a/ ..	16.8	47.3	30.9	24.6	34.0
iii) equivalent constant annual value ..	76.1	214.1	140.0	111.3	154.0

a/ Applying arithmatic series factor of 8.4 to the annual escalation of 3.36 per cent in the equipment prices over twenty-year period beyond 1974.

As the capital expenses for replacement of old equipment will be incurred progressively and not initially, their effect has been evaluated over a period of 20 years in the financial analysis Chapter 9.

8 - OPERATING COST ESTIMATES

The manpower requirements and operating cost estimates for the five alternatives for the reconstructed steelmelt shop are discussed in this chapter.

MANPOWER COST

Manpower requirements

Present strength

The present section-wise manning of the steelmelt shop is shown in Appendix 8-1. The grouping of this manpower according to skills and trades is given in Appendix 8-2. The present strength is about 1,070.

Estimated requirements

Based on this prevailing manning pattern, an estimate of different categories of personnel required for the various alternative schemes is given in Table 8-1.

Table 8-1

ESTIMATED MANPOWER REQUIREMENTS

Personnel		Alt. 1	Alt. 2	Alt. 3	Alt. 4	Alt. 5
Management and administration	..	20	20	20	20	20
Technicians and supervisory staff	..	116	124	116	113	141
Skilled workers	..	283	313	287	283	343
Semi-skilled workers	..	367	617	559	355	483
Clerical and office staff	..	18	18	18	18	18
Total	..	[illegible]	1,092	1,000	789	1,005

It will be noted that in all the alternatives (except Alternative 2), the requirement of manpower would be somewhat less than the present strength of 1,070, the greatest reduction being in Alternative 4 closely followed by Alternative 1. It is presumed that the manpower rendered surplus will be absorbed in suitable positions in the expansion complex.

Annual wage bill

Annual labour cost

The wage bill is estimated on the basis of the revised manpower requirements. The average wage of the employees in the Thomas shop during the last two years has remained steady at $ 715 per man-year and this figure has been used for arriving at the annual labour cost for the different alternatives as shown in Table 8-2.

Table 8-2

ESTIMATED ANNUAL LABOUR COST

	Alt.1	Alt.2	Alt.3	Alt.4	Alt.5
Total men on pay roll ..	824	1 092	1 000	789	1 005
Total annual cost ('000 $)	589	781	715	564	719
Average cost/ton of ingot ($) ..	1.55	2.05	1.88	1.48	1.89

The cost of manpower per ingot ton shown in Table 8-2 is a composite figure for operations of the converters and electric arc furnaces for Alternatives 2 and 5. The lowest manpower cost is obtained in Alternative 4 closely followed by Alternative 1. The highest manpower cost of $ 2.05 per ingot ton is obtained in Alternative 2.

The purpose of this manpower estimate is mainly to arrive at the labour component of the production cost for the different alternatives.

ESTIMATES OF OPERATING COSTS

Operating costs include all costs associated with the conversion of the raw materials into ingots. In keeping with the steel plant accounting practice, operating cost is estimated under two heads - 'materials cost' and 'cost above materials'.

Unit cost of materials and utilities

The unit costs of materials used for steelmaking as delivered at the plant site and the unit costs of utilities during the last five years at the Helwan steel plant have been studied. Based on the discussions with HADISOLB, the unit costs of materials and utilities assumed for the purpose of calculating the operating costs in the reconstructed steelmelt shop are given in Table 8-3.

8 - Operating cost estimates (cont'd)

Table 8-3

UNIT COSTS OF MATERIALS AND UTILITIES

Item	Unit	Unit cost $
MATERIALS		
Low phosphorus hot metal (with Bahariya ore) ..	ton	47.76
High phosphorus hot metal (with Bahariya ore and phosphate rock) ..	ton	50.33
Ferro-manganese (75% grade)	ton	262.01
Ferro-silicon (75% grade)	ton	323.45
Aluminium	ton	839.87
Burnt lime - produced and purchased ..	ton	77.59
UTILITIES		
Steam	ton	2.72
Power	'000 kWh	13.98
Compressed air ..	'000 cu m	1.77
Air blast	'000 cu m	1.51
Fuel oil	ton	17.48
Water	'000 cu m	12.93
Oxygen	'000 cu m	27.00

Materials cost

The material consumption is based on the process

Yield

requirements and the estimated average yields as shown in Table 8-4.

Table 8-4

CONVERTER YIELDS

		Metallic to ingot a/ %
Alt. 1	..	86.0
Alt. 2	..	84.0
Alt. 3	..	85.0
Alt. 4	..	86.5
Alt. 5	..	84.0

a/ The average yield from metallics to ingot for the electric arc furnaces is 86.5 per cent.

8 - Operating cost estimates (cont'd)

Credit

Credit is allowed for the following by-products, in working out the net cost of materials:

i) short and rejected ingots,

ii) ladle skull and,

iii) high phosphorus Thomas slag for Alternatives 2 and 3 (which is used as fertiliser).

The credit for short and rejected ingots, ladle skull and Thomas slag is allowed at the rates of $ 59, $ 30 and $ 4.5 per ton respectively, based generally on the 1970/71 costing practice of HADISOLB.

Cost above materials

'Cost above materials' covers all other items of expenditure incurred in processing the raw materials, such as labour and supervision, power, fuel, water, refractories, supplies and lubricants, repairs and maintenance and general plant expenses. The manpower cost per ton of ingot has been taken according to Table 8-2. The costs of other items are based on the prevailing costs at the steel plant.

As regards the expenses on repairs and maintenance, the present figures obtaining at the steel plant have been taken as the basis. For the new equipment, provision has been made at 3 per cent of the installed cost.

Operating cost

Estimates of operating cost per ton of ingot for the various alternatives are given in Appendix 8-3. The estimated annual operating costs are given in Table 8-5. It will be noted that in Alternatives 2 and 5, the electric furnaces are retained and the operating costs for the electric furnaces are shown separately.

Table 8-5

ANNUAL OPERATING COSTS

Alternative	Annual operating cost: Cost of materials '000 $/yr	Cost above materials '000 $/yr	Total '000 $/yr
Alt. 1 - LD ..	23 062	7 277	30 339
Alt. 2 - Thomas ..	21 212	7 491	28 703
- Electric ..	3 105	2 116	5 221
Total of Alt. 2 ..	24 317	9 607	33 924
Alt. 3 - Thomas ..	24 149	8 375	32 524
Alt. 4 - OBM ..	22 967	7 231	30 198
Alt. 5 - Side-blown ..	20 196	8 877	29 073
- Electric ..	3 105	2 116	5 221
Total of Alt. 5 ..	23 301	10 993	34 294

8 - Operating cost estimates (cont'd)

PRODUCTION DURING TRANSITION PERIOD

The transition period includes the period of reconstruction as well as of gestation to attain the rated capacities after commissioning all the reconstructed facilities.

Production during reconstruction

During the reconstruction period, the scheduling of the construction activities has been so planned as to minimise the actual shut-down of the operating units and to achieve as much production as possible. This aspect has been discussed in detail in Chapter 7, and the production that could be reasonably expected during the construction period for the various alternatives has been estimated.

Production during gestation period

As the present shop floor personnel are experienced in the operation of Thomas converters only, it is expected that they would require some time to acquire the necessary experience in the operation of other steelmaking practices such as the LD, OBM and side-blown converters. The anticipated gestation periods to reach the rated capacity and capacity utilisation during the gestation period in the various alternatives are shown in Table 8-6.

8 - Operating cost estimates (cont'd)

Table 8-6

CAPACITY UTILISATION DURING GESTATION PERIOD

Year from commissioning		Production as percentage of rated capacity				
		Alt. 1	Alt. 2	Alt. 3	Alt. 4	Alt. 5
First	..	70	100	90	60	60
Second	..	90	100	100	90	90
Third	..	100	100	100	100	100

It is reasonable to expect that the rated capacity from the existing Thomas converters under Alternative 2 will be achieved during the first year itself. Though the production equipment under Alternative 3 consists of Thomas converters, a 10 per cent shortfall in the utilisation of the installed capacity during the first year has been allowed for possible teething troubles in the new installation. A time lag of three years for Alternatives 1, 4 and 5 would appear realistic, the production rising to 60 per cent , 90 per cent and 100 per cent of the installed capacity during these three successive years. As the personnel trained in the operation of LD converters from the expansion complex could be made available for the reconstructed Thomas shop, a higher utilisation of the installed capacity to the extent of about 10 per cent is assumed for the first year under Alternative 1.

8 - Operating cost estimates (cont'd)

Total production during transition

The output of steel that can be expected during the transition period till the production reaches the rated capacity in the reconstructed steelmelt shop, after taking into account the effects of shut-down of the Thomas converter operations and the gestation under the different alternatives, are shown in Table 8-7.

Table 8-7

ANTICIPATED PRODUCTION DURING TRANSITION PERIODS a/
('000 tons)

Year from 'go-ahead'	Steelmaking equipment	Alt. 1	Alt. 2	Alt. 3	Alt. 4	Alt. 5
Second	Converter	-	183.3 b/	-	183.3 b/	-
	Electric fce	50	50	50	50	50
Third	Converter	-	275 c/ (100)	25.3 c/ (80)	171 c/ (60)	-
	Electric fce	50	50	45.8 d/	12.5 d/	50
		50	325	71.1	183.5	50
Fourth	Converter	266 (70)	330 (100)	342 (90)	342 (90)	198 (60)
	Electric fce	-	50	-	-	50
		266	380	342	342	248
Fifth	Converter	342 (90)	330 (100)	380 (100)	380 (100)	297 (90)
	Electric fce	-	50	-	-	50
		342	380	380	380	347

a/ Production during first year will continue to be at the present level of 250,000 tons for all alternatives. Figures in brackets indicate the anticipated percentage utilisation of rated capacity.

b/ Production for the first 11 months only and shut-down in the twelfth month.

c/ Production during the last 10, 1 and 9 months for Alternatives 2, 3 and 4 respectively.

d/ Production for the first 11 and 3 months for Alternatives 3 and 4 respectively.

Annual operating cost during transition

In estimating the annual operating cost for the production level that will be obtained during the transition period, the cost during the first year from the 'go-ahead' signal has not been taken into account as the production in all the alternatives would continue at the present level. The losses due to shut-down of the operating units during the second and third years have been accounted for in the capital cost estimates in Chapter 7. Therefore, only the operating expenses pertaining to the production from the reconstructed facilities, from the time they are commissioned till they reach their rated capacities, have been estimated. However, the operating expenses of the electric arc furnaces, for such periods as they are kept in operation during the third year for the various alternatives, have been included in this estimate. As the arc furnaces continue to operate in all the alternatives during the second year from the 'go-ahead' signal, their operating expenses will be the same for all the alternatives and have therefore not been taken into account for this comparative evaluation.

During the gestation period of the reconstructed steelmelt shop, the costs of labour and supervision and repair and maintenance expenses would remain constant, while

8 - Operating cost estimates (cont'd)

other operating expenses will generally vary with the capacity utilisation. The annual operating expenses have been computed on this basis in Appendix 8-4 and summarised in Table 8-8. As the reconstructed shop will attain the rated capacity under all the alternatives in the sixth year from the date of 'go-ahead' signal, the estimates of annual operating expenses from this year onwards remain unchanged.

Table 8-8

ANNUAL OPERATING EXPENSES DURING TRANSITION PERIOD
(in '000 $)

Annual operating expenses		Alt. 1	Alt. 2	Alt. 3	Alt. 4	Alt. 5
Third year						
Variable	..	4 981	27 726	6 634	14 245	4 981
Fixed	..	240	1 414	340	1 055	240
Total	..	5 221	29 140	6 974	15 300	5 221
Fourth year						
Variable	..	20 264	32 275	27 976	25 985	21 702
Fixed	..	1 391	1 649	1 490	1 326	1 444
Total	..	21 655	33 924	29 466	27 311	23 146
Fifth year						
Variable	..	26 054	32 275	31 084	28 872	30 063
Fixed	..	1 391	1 649	1 440	1 326	1 444
Total	..	27 445	33 924	32 524	30 198	31 507
Sixth year onwards						
Variable	..	28 948	32 275	31 084	28 872	32 850
Fixed	..	1 391	1 649	1 440	1 326	1 444
Total	..	30 339	33 924	32 524	30 198	34 294

9 - EVALUATION OF ALTERNATIVES

Financial evaluation

The financial implications of the five alternatives are evaluated in this chapter. The profitability of a project is usually assessed on the basis of expected sales realisation. In the present case, however, fixing of a sales price for the steel ingot for working out the profitability would be a notional exercise of limited value, as the ingot is only an intermediate product. It is, therefore, necessary to adopt a more suitable method to evaluate the impact of the additional fixed investment estimated for the various alternatives.

Method adopted

The method adopted for the financial evaluation in the present context is to work out (i) the savings in the operating costs effected by reconstruction in each of the alternatives compared to the current operating cost with the existing facilities and (ii) the benefits resulting from increased production capacity arising out of the additional investment. The total annual value of these savings and benefits is treated as return on the additional investment estimated for the various alternatives.

As the current operating cost of HADISOLB is based on the use of hot metal produced from Aswan ore, it needs

9 - Evaluation of Alternatives (cont'd)

to be revised on the basis of using Bahariya ore in the existing steelmelt shop facilities to make it comparable with the operating cost estimates of the alternative schemes where hot metal produced from Bahariya ore will be refined. During 1970/71, the combined average cost of ingot steel made from Thomas converters and electric furnaces was about $ 139 per ton excluding fixed charges. Assuming a level of production of 200,000 tons of Thomas steel and 50,000 tons of electric furnace steel from the existing facilities, the combined average cost is estimated at $ 92.65 per ton of ingot, if hot metal produced from Bahariya ore with necessary rephosphorisation were refined in the Thomas converters. Details of these estimates are given in Appendix 9-1.

In regard to the operating costs for the five alternatives, the annual estimates have been worked out in Chapter 8.

Evaluation criteria

The five alternative schemes are evaluated with reference to the following criteria of financial profitability and these are compared with the estimated operating cost using the existing steelmelt shop facilities on the basis of switch-over to Bahariya ore as explained above:

i) total annual cost and average cost per ingot ton including incidence of fixed charges on the additional investment,

9 - Evaluation of alternatives (cont'd)

ii) present worth of capital and operating outlays per ingot ton,

iii) internal rate of return on the additional investment and

iv) pay-back period of the additional investment calculated on discounted basis.

Annual and unit costs

Fixed charges are computed only with reference to the additional facilities which are proposed for reconstruction. Depreciation charges on the investment in equipment and buildings are calculated at a composite rate of 5 per cent per annum. Depreciation charges on replacement items are also provided at the same rate, on the basis of adjusted figure for progressive replacement of equipment over a period of 20 years at an annuity of 6.5 per cent. The fixed expenses during the reconstruction period comprising expenses of dismantling the existing facilities, shut-down expenses, engineering services, and interest on capital during construction are amortised on straightline basis at 5 per cent per annum.

Interest charges

Interest on working capital is computed at 8 per cent per annum. Working capital requirements are estimated as equivalent to the operating expenses for 3 months. This provision includes initial requirement of imported spare parts which would be around 5 per cent of the value of imported equipment for each alternative. Interest charges on long-term borrowings are provided at 6.5 per cent per annum. Long-term borrowings include loans in respect of initial fixed investment and funds required for progressive replacement of equipment.

Taking the average annual production in a normal year at the full rated capacity of 380,000 tons per year, the estimates of annual operating expenses and fixed charges for each of the five alternatives are computed in Appendix 9-2 and summarised in Table 9-1.

Table 9-1

ANNUAL COSTS INCLUDING FIXED CHARGES

	Alt. 1	Alt. 2	Alt. 3	Alt. 4	Alt. 5	Existing facilities
Annual cost ('000 $/yr)						
Annual operating expenses	30 339	33 924	32 524	30 198	34 294	23 162
Annual fixed charges	2 858	1 446	1 881	1 754	1 816	-
Total	33 197	35 370	34 405	31 952	36 110	23 162
Unit cost ($/ton of ingot)						
Unit operating expenses	79.84	89.27	85.59	79.47	90.25	92.65
Fixed charges per unit	7.52	3.81	4.95	4.61	4.78	-
Total	87.36	93.08	90.54	84.08	95.03	92.65

9 - Evaluation of alternatives (cont'd)

Annual cost per ton lowest for Alt. 4

It will be observed that the ingot cost of $ 84.08 per ton (including fixed charges) is the lowest and is obtained in Alternative 4 using the OBM (Q-BOP) process. Alternative 1, adopting the LD process, gives the second lowest cost of $ 87.36 per ton. Alternative 5, based on side-blown converters, results in the highest cost.

Present worth analysis

Present worth

For the purpose of calculating the present worth of the capital and operating outlays, the discount rate of 7 per cent per annum has been assumed. The zero point is fixed at 2 years from the date of the 'go-ahead' signal for the reconstruction, since a substantial part of the capital outlays under most of the alternatives will be incurred during this period and the reconstructed facilities would be commissioned under three of the five alternatives by the third year from the 'go-ahead' signal. As the production schedule is also varying under the different alternatives according to the time of commissioning of initial facilities and the gestation period required during the initial period of operation, the quantities of output in the various operating years are also discounted at a uniform rate of 7 per cent per annum. The present worth of the various alternatives is, therefore, assessed with reference to the discounted present worth of the total capital and operating outlays and also with reference to the present worth of these outlays per ton of production. For this purpose, the discounted present worth of the outlays is divided by the discounted total quantity of production over a 20-year period of operation.

Residual worth

Provision is made for the residual value of the total investment in fixed facilities on a notional basis at 15 per cent of the initial capital block of the reconstructed facilities. The residual worth of the equipment progressively installed to replace the old equipment has been assumed to be the same as the written-down book value that would obtain at the end of the 20th year assuming depreciation at a rate of 5 per cent per annum by straightline method.

The calculations of the present worth of the outlays for the five alternatives as well as for the existing facilities are worked out in Appendix 9-3. A summary of these calculations is presented in Table 9-2.

9 - Evaluation of alternatives (cont'd)

Table 9-2

PRESENT WORTH CALCULATIONS
(discount rate - 7 per cent)

	Unit	Alt. 1	Alt. 2	Alt. 3	Alt. 4	Alt. 5	Existing facilities
Discounted present value of:							
Capital outlays ..	'000 $	17 947	6 683	9 895	9 901	9 227	-
Operating outlays ..	'000 $	287 973	354 918	318 000	303 467	324 121	245 378
Total outlays ..	'000 $	305 920	361 601	327 895	313 368	333 348	245 378
Output ..	'000 t	3 587	3 974	3 704	3 809	3 575	2 649
Unit production - Discounted outlays/ Discounted output ..	$/t	85.29	90.99	88.52	82.27	93.24	92.65

Present worth lowest for Alternative 4

It will be noted that amongst the five alternatives, Alternative 1 yields the lowest present worth in terms of outlay. However, the unit cost per ton of production is the lowest for Alternative 4 at $ 82.27 per ton as compared to the corresponding figures of $ 85.29 per ton for the second lowest obtained in Alternative 1, and $ 92.65 per ton if the present steelmelt shop operations are continued without any additional investment.

Internal rate of return

Inflows and outflows

The cash savings in the cost of operation per ingot ton under the different alternatives compared to the present cost level have been multiplied by the annual output to arrive at the total cash savings in the operating

9 - Evaluation of alternatives (cont'd)

cost over a period of 20 years, as a result of the additional investment. The residual worth of fixed facilities and equipment has been estimated on the same basis as for the present worth analysis. The interest on working capital has been calculated at 8 per cent per annum on the same basis as was done for the determination of fixed charges for the annual cost. Outflows by way of fixed investment during the three years above the zero point have been compounded. All outflows below the zero point and all cash inflows representing savings in the operating years have been discounted. All outflows are assumed to be occurring at the beginning of each year and inflows to accrue at the end of each year.

Internal rate of return

The present values of outflows and inflows have been estimated in Appendix 9-4 with suitable trial rates. In each case, the ratio of total investment to capital recovery is worked out. These ratios are thereafter plotted on an interpolation chart from which the actual internal rates of return are determined. The results thus obtained for the different alternatives are as follows:

		Internal rate of return %
Alt. 1	..	14
Alt. 2	..	5
Alt. 3	..	12
Alt. 4	..	25
Alt. 5	..	negative

9 - Evaluation of alternatives (cont'd)

Highest internal rate of return for Alt. 4

The highest internal rate of return of 25 per cent is obtained under Alternative 4. Alternative 1 gives the second highest rate of return at 14 per cent, followed closely by Alternative 3 with a figure of 12 per cent.

Pay-back period

The pay-back periods for the five alternatives are worked out in Appendix 9-5 by compounding all capital expenses during reconstruction at the rate of 7 per cent per annum up to the zero point and discounting all savings in the operating expenses (including interest charges on working capital) and annual capital expenditure on the progressive equipment replacement at the same rate below the zero point. The approximate pay-back periods are as follows:

		Years
Alt. 1	..	9
Alt. 2	..	40
Alt. 3	..	10
Alt. 4	..	4
Alt. 5	..	not attained

Results of financial evaluation

The results of the financial evaluation are summarised in Table 9-3.

9 - Evaluation of alternatives (cont'd)

Table 9-3

RESULTS OF FINANCIAL EVALUATION

		Unit	Alt. 1	Alt. 2	Alt. 3	Alt. 4	Alt. 5
Fixed investment a/	..	million $	17.37	4.77	8.83	8.62	7.94
Unit cost at rated capacity including fixed charges	..	$/ingot ton	87.36	93.08	90.54	84.08	95.03
Present worth of capital and operating outlays	..	$/ingot ton	85.29	90.98	88.52	82.27	93.24
Internal rate of return	..	%	14	5	12	25	negative
Pay-back period	..	years	9	40	10	4	negative

a/ Excluding capitalised interest charges during construction.

The above analysis reveals that Alternative 4 based on the OBM (Q-BOP) process is the most attractive from the financial angle. The next in order is Alternative 1 adopting LD convertors. This is followed by Alternative 3 employing larger (24-ton) Thomas convertors. Alternative 2 which envisages augmenting the Thomas steel production from the existing converters and the retention of the electric furnaces ranks fourth. Alternative 5 using side-blown converters and retaining the electric arc furnaces is the most uneconomical as the rates of return on investment is negative and the pay-back period is not attained.

9 - Evaluation of alternative (cont'd)

Conclusions

Before finally selecting the most suitable alternative, besides the financial evaluation, it is also necessary to consider other factors such as the status of the process; the flexibility of the process in regard to the types of hot metal that can be refined and the amount of scrap that can be melted; the quality of steel that can be produced; the actual period of shut-down of the production units during the reconstruction time; and the production loss during such shut-down. The merits and demerits of the various alternatives in the light of these techno-economic considerations are given in Table 9-4.

It will be observed that Alternative 4 which envisages change-over to the OBM process is not only financially the most attractive but is acceptable in other respects also.

The OBM process, though a recent innovation, is already proven and is gaining rapid commercial acceptance. The total world capacity including the capacity under installation is estimated at over 14.2 million tons as detailed in Appendix 3-1. Bulk of this capacity has been created by modifying Thomas converter shops. It will be noted from Appendix 3-1 that the OBM process has been adopted already in 10 Thomas converter shops. U.S. Steel Corporation is installing two 200-ton OBM (Q-BOP) converters in the existing open hearth-shop at their Fairfield Works.

9 - Evaluation of alternatives (cont'd)

Table 9-4

COMPARISON OF ALTERNATIVE SC

Item		Alt. 1 LD Converter	Alt. 2 Existing Thomas Converter
Fixed investment, million $	..	17.37	4.77
Unit production cost (including fixed charges), $ per ingot ton	..	87.36	95.08
Internal rate of return, per cent	..	14	5
Pay-back period, years	..	9	40
Annual production from reconstructed Thomas shop, tons	..	380 000	330 000
Heat size (metallic charge), tons	..	23	19
Number of converters	..	3	4
Number of operating converters	..	2	2
Heat time, minutes	..	48	45
Number of heats per converter per day	..	30	32
Yield - metallics to ingot, per cent	..	86	84
Status of process ..	..	Leading process at present	Almost obsolete
Quality of steel ..	..	Comparable to open-hearth quality - various grades incl low alloy steels are being produced	High nitrogen and inclusion content - all grades of steels cannot be produced
Quality of hot metal ..	..	Only low-phosphorus hot metal can be used	Only high-phosphorus hot metal can be used
Ability to melt scrap ..	..	Up to about 30% of charge weight	In small percentage only
Reconstruction time, months	..	36	26
Shut-down during reconstruction, months	..	24	3
Loss of steel production during shut-down, tons ..	..	400 000	50 000
Manpower requirement ..	..	824	1 092

SECTION 1

Table 9-4

COMPARISON OF ALTERNATIVE SCHEMES

Alt. 2 Existing Thomas Converter	Alt. 3 24-ton Thomas Converter	Alt. 4 OBM Converter	Alt. 5 Basic side-blown Conv.
4.77	8.83	8.62	7.94
95.08	90.54	84.08	95.05
5	12	25	Negative
40	10	4	Negative
330 000	380 000	380 000	330 000
19	24	22	28
4	4	3	4
2	2	2	2
45	48	45	57
32	30	32	25
84	85	86.5	84
Almost obsolete	Almost obsolete	Recent innovation gaining commercial acceptance	Not adopted for tonnage steel production
High nitrogen and inclusion content - all grades of steels cannot be produced	High nitrogen and inclusion content - all grades of steels cannot be produced	Reported to be superior to Thomas steel and comparable to open-hearth and LD quality	...
Only high-phosphorus hot metal can be used	Only high-phosphorus hot metal can be used	Both high as well as low phosphorus hot metal can be used	...
In small percentage only	Up to about 15% of charge weight depending on the oxygen enrichment of the blast	Up to about 35% of charge weight	
26	35	27	33
3	23	4	24
50 000	384 000	67 000	400 000
1 092	1 000	789	1 005

9 - Evaluation of alternatives (cont'd)

In fact, the U.S. Steel has found the process attractive enough that half-way through the construction of the new LD shop at Gary, they are changing the 200-ton LD vessels to OBM converters. The Sydney Steel Corporation in Canada are reported to be replacing the existing open-hearth with 120-ton OBM converters. The Surahammars Bruks in Sweden are installing a 40-ton OBM converter. From the trend, it appears that the OBM process will make increasing inroads into the field of steelmaking.

In regard to the versatility of the process, the OBM can refine both low-phosphorus and high-phosphorus hot metal whereas the LD is suitable for only low-phosphorus iron and the Thomas converter can refine only high-phosphorus iron. The OBM process can also use higher percentage of scrap in the charge than the LD. The quality of OBM steel is reported to be much superior to Thomas steel and to be comparable to open-hearth and LD steel qualities.

Conversion of the Helwan Thomas converter plant to the OBM process will not call for extensive modifications. Further, the actual shut-down period required for conversion of the existing steelmelting operations is estimated to be about four months only, and the loss of production during the shut-down period would be approximately 67,000 tons which is not excessive. The manpower requirement for the OBM operation is the lowest of all the alternatives. Moreover, as the production obtainable from the OBM convertors is about 380,000 tons of ingot steel, the arc furnaces could be shut-down.

In view of the above considerations, Alternative 4 adopting the OBM process is recommended as a suitable scheme for reconstructing the existing Thomas convertor shop to refine iron produced from Bahariya ore and to meet the proposed production requirements.

It needs to be emphasised that the cost data and implementation schedules presented in this report are only indicative of the order of magnitude for the purpose of evaluation of the various alternatives. For the OBM process, the cost figures and the process parameters given in this report are based on published information. Details of these are not available as they are precluded from public discussion by non-disclosure agreements between the promoters, licencees and operating companies. Before implementing the project, it will also be necessary to enter into a suitable collaboration arrangement with the promoters of the OBM process to obtain the process know-how and guarantees, and to define the costs more precisely.

A P P E N D I C E S

Appendix 1-1

EXTRACT FROM UNIDO CONTRACT OF 18TH OCTOBER 1971
AND SUBSEQUENT AMENDMENTS

The terms of reference of this contract as well as subsequent amendments are as follows:

A. CONTRACT NO. 71/64 (PROJECT NO. SIS 70/1125)

1.00 BACKGROUND AND AIM OF THE PROJECT

1.01 BACKGROUND

Helwan iron and steel works is being expanded (through bilateral assistance of USSR) to a crude steel annual capacity of about 1.5 million tons. At present, highly phosphoric iron ore from Aswan is smelted at Helwan. However, in the expanded Helwan iron and steel works, low phosphorus Bahariya iron ore from the Western desert in the UAR will be used for iron production. This raw material switchover will entail technological process changes. Pig iron smelted from Bahariya iron ore cannot be refined into steel by the Thomas converter steelmaking process; it will be treated in an oxygen LD converter. This change-over of the steelmaking process will mean that the Thomas converter steel shop will be idle at the expanded Helwan steel plant. It is, therefore, necessary to study technological ways and means to utilise the existing facilities of the Thomas converter shop including its ancillaries (cranes, and handling equipment). Various alternatives have been proposed. It

Appendix 1-1 (continued)

is necessary to comprehensively examine these and other promising alternatives on sound techno-economic parameters, including the capital and operational costs of implementing them.

1.02 AIM OF THE PROJECT

The aim of the Project is to provide the Government with basic information and technical data on the possible utilization of existing Thomas steelmaking shop which will become redundant when the projected switch-over is made from Aswan iron ore to Bahariya iron ore for iron smelting.

2.00 RESPONSIBILITIES OF THE CONTRACTOR

2.01 STATEMENT OF WORK

Bearing in mind the background and the aim of the project the Contractor shall under the terms hereinafter set forth:

a) review all the existing information on the expansion of Helwan Steel Plant with particular emphasis on the steelmaking facilities;

b) examine from the technical and economic view points the various possible alternatives for the modifications of the steel smelting shop including -

(i) replacement of the Thomas steelmaking converters with LD oxygen converters and consequent reconstruction of the steelmelting shop;

Appendix 1-1 (continued)

(ii) modifications of the existing Thomas converters in order to increase their capabilities;

(iii) combination of steelmaking facilities namely, installation of LD oxygen converters using iron made from low phosphorus Bahariya iron ore and continuation of the operation of the existing Thomas converter steelmaking shop with iron smelted from phosphoric Aswan iron ore.

c) study and evaluate other promising alternatives for modifications of the steelmelting shop and further -

(i) determine and recommend after critical examination the best techno-economic alternative;

(ii) estimate the capital and operating cost for the recommended alternative;

(iii) suggest a tentative plan of implementation for this alternative to serve as a basis for further action by the Egyptian Organization for Metallurgical Industries.

B. AMENDMENT NO. 2 DATED 18TH JANUARY 1972

The amendment No. 2 covers the following changes in Statement of Work paragraph 2.01, sub-paragraph (b):

Appendix 1-1 (continued)

2.01(b) Examine from the technical and economic viewpoints the various possible alternatives for the modifications of the steelmelting shop including:

(i) the reconstruction of the steel works and the replacement of the Thomas converters by LD converters;

(ii) the modification of the existing Thomas converter in order to raise the capacity from 17 tons/heat to 20-25 tons/heat;

(iii) any acceptable alternative proposal appropriate as a solution.

C. UNIDO'S LETTER NO. TP/MM/iml OF 21ST MARCH 1972

Aim of the Project - Add sentence reading as follows to Clause 1.02:

"The reconstructed Thomas shop is expected to produce about 330,000 tons of steel ingots per annum using the Bahariya ores".

Delete Clause 2.01 (a) reading as follows from the Statement of Work:

"review all the existing information on the expansion of Helwan Steel Plant with particular emphasis on the steelmaking facilities".

Appendix 1-2

VISIT OF CONSULTING ENGINEERS' EXPERTS TO CAIRO/HELWAN

Expert	Field of activity	Period of stay	
		From	To
M.N. Dastur	Metallurgical Engineer	14.2.1972	17.2.1972
T.V.S. Ratnam	Electrical & Metallurgical Engineer	18.2.1972	1.3.1972
A.K. Lahiri	Metallurgical Engineer	10.2.1972	27.3.1972
B.C. Jhaveri	Economist	18.2.1972	27.3.1972
H. Klinar	Metallurgical Strategist	24.2.1972	29.2.1972

Appendix 1-3

PERSONS AND ORGANIZATIONS CONTACTED

The Consulting Engineers gratefully acknowledge the co-operation and help extended by all persons and organizations in Vienna and the Arab Republic of Egypt in connection with this Study. However, as the number of persons and organizations contacted have been large, it has not been possible to list all of them here.

	Organisation	Persons met
1.	United Nations Industrial Development Organization, Vienna	Dr Luiz C. Correa da Silva, Senior Industrial Development Officer; Chief, Metallurgical Section
2.	-do-	Mr Adnan A. Tamimi
3.	-do-	Mr M. Micillo
4.	United Nations Development Programme, Cairo	Mr V.P. Pavicic, Resident Representative
5.	-do-	Mr K.P. Dalal, Deputy Resident Representative
6.	-do-	Dr A.A. Vassiliev, Deputy Resident Representative/Senior Industrial Field Adviser
7.	-do-	Mr T.L. Gordon S. Somers, Assistant Resident Representative
8.	-do-	Mr Th. Sabry, Programme Officer

Appendix 1-3 (continued)

	Organization	Persons met
9.	The Egyptian General Organization for Metallurgical Industries, Cairo	Dr Mahmud Ali Hassan, President
10.	-do-	Eng Tarek Hassanein, General Manager (Acting)
11.	-do-	Mr Khalil Abou-Alam, Project Manager
12.	The Egyptian Iron and Steel Company, Helwan	Mr Ali Moursi, Chairman
13.	-do-	Mr Mohamed Kamel Eyada, Works General Manager
14.	-do-	Alfons Ghattas Gobrial, Manager Projects Department
15.	-do-	Mr Moh. Dia El-Din Fahmy
16.	-do-	Dr Eng. Ezzat Maarouf
17.	-do-	Dr Abdul Rauf Radwan, Manager, Blast Furnace and Sinter Plant
18.	-do-	Eng Clemen Ballan, Chief Engineer, Blast Furnace and Sinter Plant
19.	-do-	Mr Ali El Ganini, Manager, Steelworks
20.	-do-	Mr Mohamedi Soleman, Chief, Power and Utilities Department
21.	-do-	Mr El Kadi, Chief Mechanical Erector
22.	-do-	Mr F. Aref, Production Control Department
23.	-do-	Mr Awad Osman Saleh, Chief Cost Accountant

Appendix 2-1

LIST OF MAJOR EQUIPMENT ORIGINALLY PROVIDED IN THE STEELMELT SHOP

	Equipment	Remarks
One	(1) - 500-ton capacity hot metal mixer	
Three	(3) - 17-ton capacity Thomas converter complete with control system, control gear for hydraulic tilting drive, swing out spout burners, air box cover lifting device, tuyure plates, tuyure blocks for burning of converter bottom etc.	
Two	(2) - 12-ton capacity electric arc furnace and accessories	
One	(1) - Jack car for fixing the converter bottom	
One	(1) - Elevating platform for relining the converter shell	
	- Mono-rail system for lime transfer	
One	(1) - Casting car for 15-ton capacity ladle	
Three	(3) - 17-ton capacity hot metal charging ladle	
Seven	(7) - 15-ton capacity steel casting ladle	
Four	(4) - 15-ton capacity ladle for arc furnace	
Twentyfour	(24) - 3 cu m capacity slag pot	
Four	(4) - Scrap basket for electric furnace	
One	(1) - Scrap basket car	
Twentyfour	(24) - Flat car for 3 cu m capacity slag pot	
Ten	(10) - 1.5 cu m capacity lime bucket	
Eight	(8) - Ingot car	
One	(1) - Stopper rod drier	
Five	(5) - Ladle drier	2 for electric furnace ladles
Four	(4) - Ladle stands	
One	(1) - 70-ton capacity track scale for hot metal car	
One	(1) - 30-ton capacity track scale for ingot transfer	
One	(1) - 30-ton capacity track scale for scrap transfer	

Appendix 2-1 (continued)

	Equipment	Remarks
One	(1) - 25-ton capacity platform scale for mixer	
Three	(3) - 1-ton capacity dial scale for additions	
One	(1) - Ferro-manganese preheating furnace	Dismantled
Two	(2) - 35,000 cu m/hr capacity air blower	
Two	(2) - Centrifugal pump for hydraulic plant	
One	(1) - 15-ton/day capacity dolomite shaft kiln and auxiliaries	
	- Dolomite preparation plant complete with crusher, feeder, screen etc	
	- Tar storage and heating installation	
Two	(2) - 1.5 ton/hr capacity pan mill	
One	(1) - Converter bottom ramming machine	
One	(1) - Semi-automatic revolving brick press	
Six	(6) - Converter bottom baking oven	
One	(1) - High pressure air compressor	Dismantled
One	(1) - 50/10-ton capacity hot metal charging crane	
Two	(2) - 25/5-ton capacity ladle crane	
One	(1) - 10-ton capacity mould preparation crane	
One	(1) - 3-ton capacity lime bucket crane	
One	(1) - 3-ton capacity mono-rail trolley	
One	(1) - 16/3-ton capacity crane for electric furnace aisle	
One	(1) - 16/3-ton capacity ladle crane in ladle aisle	
One	(1) - 12.5-ton capacity crane in bottom preparation aisle	
One	(1) - 20-ton capacity crane in blower plant	
One	(1) - 8-ton capacity magnet crane	

Appendix 2-2

LIST OF ADDITIONAL FACILITIES PROVIDED IN STEELMELT SHOP

Equipment	Year of installation
One (1) - 10-ton capacity stripper crane	1962
One (1) - 15-ton capacity dolomite shaft kiln	1965/66
One (1) - 17-ton capacity mixer ladle	1966
Three (3) - 15-ton capacity casting ladle	1966
One (1) - 3-ton capacity mono-rail trolley	1966
One (1) - Jack car for converter bottom changing	1967
One (1) - 17-ton capacity Thomas converter and accessories	March 1967
One (1) - Cupola for melting ferro-alloys	1968
Two (2) - 1,000 cu m capacity air compressor	-
Two (2) - Bottom baking oven	1968
Tar preparation and heating system	1969/70
One (1) - Converter bottom making machine	1971
One (1) - 50/10-ton capacity mixer crane	January 1972

Appendix 2-3

ANALYSIS OF RAW MATERIALS FOR STEELMAKING

	Fe %	C %	Si %	Mn %	SiO_2 %	CaO %	MgO %	R_2O_3 %	CaF_2 %	S %	P %	Loss on ignition %
Hot metal	-	3.55	0.57	1.00	-	-	-	-	-	0.05	2.00	-
Mill scale	70	-	-	-	1.3	-	-	-	-	-	-	-
Raw dolomite	-	-	-	-	0.16	32.8	19.8	0.33	-	-	-	46.5
Burnt dolomite	-	-	-	-	1.75	58.8	37.0	2.55	-	-	-	0.5
Limestone	-	-	-	-	2.5	52.8	-	-	-	-	-	42.9
Burnt lime	-	-	-	-	2.82	91.5	-	-	-	-	-	4.5
Fluorspar	-	-	-	-	1.5	-	-	-	92	-	-	-
Ferro-manganese	-	7.0	2.0	75.0	-	-	-	-	-	-	-	-
Ferro-silicon	-	0.2	75.0	-	-	-	-	-	-	0.04	0.15	-

Appendix 3-1

WORLD-WIDE LIST OF OBM INSTALLATIONS

Country and company	Plant location	Start-up date	Converters No.	Converters Heat size net tons	Crude steel capacity net tons	Remarks
Germany						
Eisenwerk-Gesellschaft Maximilianshutte GmbH	Sulzbach-Rossenberg	1967	6	35	1 100 000	First commercial user. Thomas converters converted to OBM.
Rochling'sche Eisenund Stahlwerk GmbH	Volklingen	1969	1	45	550 000	This plant operates six Thomas converters. One is now converted to OBM.
Metallhuttenwerk Lubeck GmbH	Lubeck/Herrenwyk	1970	1	5	40 000	Experimental and production unit.
France						
Societe des Aclenes et Trefileries de Neuves Maison	Chatillon	1969	4	35	600 000	Conversion of Thomas converters.
Union Siderurgique du Nord et de l'Est de la France (USINOR)	Valenciennes	1970	3	80	900 000	All commissioned in 1970. Largest vessels presently operating. Thomas converters converted to OBM.
-	Longwy	1970	2	45	400 000	
Belgium						
Cockerin-Ougree-Providence	Marchiennes	1971	2	35	440 000	Thomas converters converted to OBM.
Forges de Thy-Marcinelle et Monceau	Monceau	1971	4	35	660 000	Thomas converters converted to OBM.
Luxembourg						
Miniere & Metallurgique de Rodange	Rodange	1970	2	35	300 000	Thomas converters converted to OBM.
South Africa						
South African Iron & Steel Industrial Corp., Ltd	Pretoria	1971	1	40	(300 000)	This plant operates three 25 ton Thomas converters. One is now converted to OBM
United States						
U.S. Steel Corporation	Chicago (South Works)	1971	1	30	-	Commercial scale experimental unit.
U.S. Steel Corporation	Fairfield (Fairfield Works)	1974	2	200	3 500 000	Largest units in the world. First planned to use low-

SECTION 1

[illegible]	[illegible]	[illegible]	2	45	400 000	
Belgium Cockerill-Ougree-Providence	Marchiennes	1971	2	35	440 000	Thomas converters converted to OBM.
Forges de Thy-Marcinelle et Monceau	Monceau	1971	4	35	660 000	Thomas converters converted to OBM.
Luxembourg Miniere & Metallurgique de Rodange	Rodange	1970	2	35	300 000	Thomas converters converted to OBM.
South Africa South African Iron & Steel Industrial Corp., Ltd	Pretoria	1971	1	40	(300 000)	This plant operates three 25 ton Thomas converters. One is now converted to OBM
United States U.S. Steel Corporation	Chicago (South Works)	1971	1	30	-	Commercial scale experimental unit.
U.S. Steel Corporation	Fairfield (Fairfield Works)	1974	2	200	3 500 000	Largest units in the world. First planned to use low-phosphorus pig iron commercially - Being installed in existing open hearth shop.
U.S. Steel Corporation	Gary	1972	3	220	5 500 000	Conversion of LD converters under erection
Canada Sidney Steel Corporation	Sidney	1973	2	120	1 250 000	Replacing existing open hearth. Third vessel to be added after new blast furnace is built. First Q-BOP planned for Greenfield site.
Sweden Surahammars	Bruks	1973/74	1	40	400 000	New installation proposed in Greenfield site.
Total existing and scheduled capacity		..		..	15 600 000 net tons	
				or	14 200 000 metric tons	

Appendix 3-1

DASTUR ENGINEERING INTERNATIONAL GmbH
DUSSELDORF

SECTION 2

Appendix 4-1

ALTERNATIVE 1 - LIST OF MAJOR EXISTING FACILITIES TO BE UTILISED

		Equipment	Remarks
One	(1)	- 500-ton capacity hot metal mixer	
Fifteen	(15)	- Flat car for slag pot	
Three	(3)	- 1.5 cu m capacity lime bucket	
Five	(5)	- Ingot car	
One	(1)	- 70-ton capacity track scale for hot metal car	
One	(1)	- 30-ton capacity track scale for ingot transfer	
One	(1)	- 30-ton capacity track scale for scrap transfer	To be relocated
One	(1)	- 25-ton capacity platform scale for mixer	
Two	(2)	- 1-ton capacity dial scale for additions	
Two	(2)	- 15-tons/day capacity dolomite shaft kiln and auxiliaries	
		- Dolomite preparation plant complete with crusher, feeder, screen etc	
		- Tar storage and heating installation	
Two	(2)	- 1.5 ton/hr capacity pan mill	
One	(1)	- Tar dolomite brick press	
Two	(2)	- 1,000 cu m/hr capacity air compressor	
Two	(2)	- 50/10-ton capacity hot metal charging crane	
One	(1)	- 25/5-ton capacity scrap charging crane	Existing ladle crane to be modified
One	(1)	- 25/5-ton capacity ladle crane	To be relocated in new casting aisle
One	(1)	- 10-ton capacity mould preparation crane	
One	(1)	- 10-ton capacity stripper crane	To be relocated in new casting aisle
One	(1)	- 3-ton capacity crane for lime bucket	
One	(1)	- 16/3-ton capacity magnet crane	Existing crane in electric furnace aisle to be modified
One	(1)	- 12.5-ton capacity crane in bottom preparation aisle	
One	(1)	- 8-ton capacity magnet crane	
Two	(2)	- Lime shaft kiln and auxiliaries	

Appendix 4-2

ALTERNATIVE 1 - LIST OF MAJOR NEW FACILITIES

		Equipment
Three	(3)	- 20-ton LD converter with drive, electrics, controls, instruments, hood, lance system etc
Three	(3)	- Wet venturi type gas cleaning plant
Two sets		- Converter relining equipment including cooling fan, lining wrecking machine, relining platform, hoist etc
		- Flux handling system including high level bins, weigh hopper cars, chutes etc
Three	(3)	- Self-propelled transfer car for 25-ton ladles
Five	(5)	- 25-ton capacity hot metal charging ladle
Fifteen	(15)	- 25-ton capacity steel ladle
One	(1)	- Stopper rod oven
Three	(3)	- Ladle drier
Two	(2)	- Ladle stand
One	(1)	- Ladle relining pit
Two	(2)	- Mould transfer car
Fifteen	(15)	- 5-ton capacity scrap box
Five	(5)	- Flat car for slag pot
Twelve	(12)	- 1.5 cu m capacity lime bucket
One	(1)	- Scrap transfer car
One	(1)	- Turn table for scrap transfer
Ten	(10)	- Ingot car
One	(1)	- Tar dolomite brick press
One	(1)	- 10-ton capacity freight elevator
One	(1)	- Bucket elevator for flux handling
Two	(2)	- 50/10-ton capacity teeming crane
One	(1)	- 125 tons/day capacity oxygen plant

Appendix 4-3

ALTERNATIVE 2 - LIST OF MAJOR EXISTING EQUIPMENT TO BE UTILISED

		Equipment	Remarks
One	(1)	- 500-ton capacity hot metal mixer	
Four	(4)	- Existing Thomas converter and accessories	
Two	(2)	- Jack car for converter bottom changing	
		- Mono-rail system for lime transfer	
Two	(2)	- Existing electric arc furnaces and ancillaries	
Fifteen	(15)	- Flat car for slag pot	
Three	(3)	- 1.5 cu m capacity lime bucket	
Five	(5)	- Ingot car	
One	(1)	- 70-ton capacity track scale for hot metal car	
One	(1)	- 30-ton capacity track scale for ingot transfer	
One	(1)	- 30-ton capacity track scale for scrap transfer	
One	(1)	- 25-ton capacity platform scale for mixer	
Two	(2)	- 1,000 kg capacity dial scale for additions	
Two	(2)	- High pressure centrifugal pump	
Two	(2)	- Air blower for supplying air blast	
Two	(2)	- 15 tons/day capacity dolomite shaft kiln and accessories	
		- Dolomite preparation plant complete with crusher, feeder, screen etc	
		- Tar storage and heating installation	
Two	(2)	- 1.5 ton/hr capacity pan mill	
Two	(2)	- Converter bottom ramming machine	
One	(1)	- Brick press for dolomite bricks	
Eight	(8)	- Bottom baking oven	
Two	(2)	- 1,000 cu m/hr capacity air compressor	
Two	(2)	- 50/10-ton capacity hot metal charging crane	
Two	(2)	- 25/5-ton capacity ladle crane	One crane to be relocated in new casting aisle
One	(1)	- 10-ton capacity mould preparation crane	
One	(1)	- 10-ton capacity stripper crane	To be relocated in new casting aisle
One	(1)	- 3-ton capacity lime bucket crane	
Two	(2)	- 3-ton capacity mono-rail trolley	
One	(1)	- 12.5-ton capacity overhead crane in bottom preparation aisle	
One	(1)	- 16/3-ton electric furnace charging crane	
One	(1)	- 20-ton capacity overhead crane in blower plant	
One	(1)	- 8-ton capacity magnet crane	
Two	(2)	- Lime shaft kiln and auxiliaries	

Appendix 4-4

ALTERNATIVE 2 - LIST OF MAJOR NEW FACILITIES

			Equipment
Five	(5)	-	25-ton capacity hot metal ladle
Fifteen	(15)	-	25-ton capacity steel casting ladle
Four	(4)	-	Self-propelled transfer car for 20-ton ladles
One	(1)	-	Stopper rod oven
Four	(4)	-	Ladle drier
Three	(3)	-	Ladle stand
Two	(2)	-	Mould transfer car
One	(1)	-	Ladle relining pit
Five	(5)	-	Flat car for slag pot
Ten	(10)	-	Ingot car
Twelve	(12)	-	1.5 cu m capacity lime bucket
One	(1)	-	High pressure centrifugal pump for hydraulic plant
One	(1)	-	Air blower for supplying air blast
One	(1)	-	Brick press for dolomite bricks
Four	(4)	-	Bottom baking oven
Two	(2)	-	50/10-ton capacity teeming crane
One	(1)	-	30-tons/day capacity lime shaft kiln

Appendix 4-5

ALTERNATIVE 3 - LIST OF MAJOR EXISTING FACILITIES TO BE UTILISED

		Equipment	Remarks
One	(1)	- 500-ton capacity hot metal mixer	
Two	(2)	- Jack car	
		- Mono-rail system for lime transfer	
Fifteen	(15)	- Flat car for slag pot	
Three	(3)	- 1.5 cu m capacity lime bucket	
Five	(5)	- Ingot car	
One	(1)	- 70-ton capacity track scale for hot metal car	
One	(1)	- 30-ton capacity track scale for ingot transfer	
One	(1)	- 30-ton capacity track scale for scrap transfer	To be relocated
One	(1)	- 25-ton capacity platform scale for mixer	
Two	(2)	- 1,000 kg capacity dial scale for additions	
Two	(2)	- High pressure centrifugal pump	
Two	(2)	- Air blower for supplying air blast	
Two	(2)	- 15 tons/day capacity dolomite shaft kiln and accessories	
		- Dolomite preparation plant complete with crusher, feeder, screen etc	
		- Tar storage and heating installation	
Two	(2)	- 1.5 ton/hr capacity pan mill	
Two	(2)	- Converter bottom ramming machine	
One	(1)	- Brick press for tar dolomite bricks	
Eight	(8)	- Converter bottom burning oven	
Two	(2)	- 1,000 cu m/hr capacity air compressor	
Two	(2)	- 50/10-ton capacity hot metal crane	
One	(1)	- 25/5-ton capacity scrap charging crane	Existing ladle crane to be modified into scrap charging crane
One	(1)	- 10-ton capacity mould handling crane	
One	(1)	- 10-ton capacity stripper crane	To be relocated in the new casting aisle
One	(1)	- 3-ton capacity lime bucket crane	
Two	(2)	- 3-ton capacity mono-rail trolley	
One	(1)	- 12.5 ton capacity overhead crane in bottom preparation aisle	
One	(1)	- 20-ton overhead crane in power, water and blower plant	
One	(1)	- 16/3-ton magnet crane	Existing electric furnace charging crane to be modified into magnet crane
One	(1)	- 8-ton magnet crane	
One	(1)	- 25/5-capacity ladle crane	To be relocated in new casting aisle
Two	(2)	- Lime shaft kiln and auxiliaries	

Appendix 4-6

ALTERNATIVE 3 - LIST OF MAJOR NEW FACILITIES

			Equipment
Four	(4)	-	24-ton capacity Thomas convertor and accessories
Ten	(10)	-	Bottom for 24-ton capacity Thomas convertor
Five	(5)	-	25-ton capacity hot metal charging ladle
Fifteen	(15)	-	25-ton capacity steel ladle
Four	(4)	-	Self-propelled transfer car for 25-ton ladle
One	(1)	-	Stopper rod oven
Three	(3)	-	Ladle drier
Two	(2)	-	Ladle stand
One	(1)	-	Ladle relining pit
Two	(2)	-	Mould transfer car
One	(1)	-	Scrap transfer car
Ten	(10)	-	5-ton capacity scrap box
One	(1)	-	Turn table for scrap transfer
Five	(5)	-	Flat car for slag pot
Twelve	(12)	-	1.5 cu m capacity lime bucket
Ten	(10)	-	Ingot car
One	(1)	-	High pressure centrifugal pump for hydraulic plant
One	(1)	-	Air blower for supplying air blast
One	(1)	-	Brick press for tar dolomite bricks
Two	(2)	-	Converter bottom baking oven
Two	(2)	-	50/10-ton capacity teeming crane
One	(1)	-	40 tons/day capacity oxygen plant
One	(1)	-	60 tons/day capacity lime shaft kiln and auxiliaries

Appendix 4-7

ALTERNATIVE 4 - LIST OF MAJOR EXISTING FACILITIES TO BE UTILISED

		Equipment	Remarks
One	(1)	- 500-ton capacity hot metal mixer	
Three	(3)	- Thomas converter shell and accessories	
Two	(2)	- Jack car	
Fifteen	(15)	- Flat car for slag pot	
Five	(5)	- Ingot car	
Three	(3)	- 1.5 cu m capacity lime bucket	
One	(1)	- 70-ton capacity track scale for hot metal car	
One	(1)	- 30-ton capacity track scale for ingot transfer	
One	(1)	- 30-ton capacity track scale for scrap transfer	To be relocated
One	(1)	- 25-ton capacity platform scale for mixer	
Two	(2)	- 1,000 kg capacity dial scale for additions	
Two	(2)	- High pressure centrifugal pump	
Two	(2)	- 15-ton/day capacity dolomite shaft kiln and auxiliaries	
		- Dolomite preparation plant complete with crusher, feeder, screens etc	
		- Tar storage and heating installation	
Two	(2)	- 1.5 ton/hr capacity pan mill	
Two	(2)	- Converter bottom ramming machine	
One	(1)	- Brick press for tar dolomite bricks	
Eight	(8)	- Converter bottom burning oven	
Two	(2)	- 1,000 cu m/hr capacity air compressor	
Two	(2)	- 50/10-ton capacity hot metal crane	
One	(1)	- 25/5-ton capacity scrap charging crane	Existing ladle crane to be modified
One	(1)	- 10-ton capacity mould handling crane	
One	(1)	- 10-ton capacity stripper crane	To be replaced in new casting aisle
One	(1)	- 3-ton capacity lime bucket crane	
One	(1)	- 12.5 - ton capacity overhead crane in bottom preparation aisle	
One	(1)	- 16/3-ton capacity magnet crane	Existing electric furnace charging crane to be modified into magnet crane
One	(1)	- 8-ton capacity magnet crane	
One	(1)	- 25/5-ton capacity ladle crane	To be relocated in new casting aisle
Two	(2)	- Lime shaft kiln and auxiliaries	

Appendix 4-8

ALTERNATIVE 4 - LIST OF MAJOR NEW FACILITIES

		Equipment
Three	(3)	- Set of control system for OBM converter
		- Grinding plant for flux
		- Pressurised storage bins for flux
Five	(5)	- 25-ton capacity hot metal charging ladle
Fifteen	(15)	- 25-ton capacity steel ladle
Three	(3)	- Self-propelled transfer car for 25-ton capacity ladle
One	(1)	- Stopper rod oven
Three	(3)	- Ladle drier
Two	(2)	- Ladle stand
One	(1)	- Ladle relining pit
Two	(2)	- Mould transfer car
Twelve	(12)	- 1.5 cu m capacity lime bucket
One	(1)	- Scrap transfer car
One	(1)	- Turn table for scrap transfer
Ten	(10)	- 5-ton capacity scrap box
Five	(5)	- Flat car for slag pot
Ten	(10)	- Ingot car
One	(1)	- Brick press for tar dolomite brick
Two	(2)	- 50/10-ton capacity teeming crane
One	(1)	- 140-ton/day capacity oxygen plant

Appendix 4-9

ALTERNATIVE 5 - LIST OF MAJOR EXISTING FACILITIES TO BE UTILISED

			Equipment	Remarks
One	(1)	-	500-ton capacity hot metal mixer	
		-	Mono-rail system for lime transfer	
Two	(2)	-	Existing electric arc furnaces and ancillaries	
Fifteen	(15)	-	Flat car for slag pot	
Three	(3)	-	1.5 cu m capacity lime bucket	
Five	(5)	-	Ingot car	
One	(1)	-	70-ton capacity track scale for hot metal mixer	
One	(1)	-	30-ton capacity track scale for ingot transfer	
One	(1)	-	30-ton capacity track scale for scrap transfer	
Two	(2)	-	1,000 kg capacity dial scale for additions	
Two	(2)	-	High pressure centrifugal pump	
Two	(2)	-	Air blower for supplying air blast	
Two	(2)	-	15 tons/day capacity dolomite shaft kiln and accessories	
		-	Dolomite preparation plant complete with crusher, feeder, screen etc	
		-	Tar storage and heating installation	
Two	(2)	-	1.5 ton capacity pan mill	
One	(1)	-	Brick press for tar dolomite bricks	
Two	(2)	-	1,000 cu m/hr capacity air compressor	
Two	(2)	-	50/10-ton capacity hot metal crane	
One	(1)	-	25/5-ton capacity ladle crane	To be relocated in new casting aisle
One	(1)	-	10-ton capacity mould handling crane	
One	(1)	-	10-ton capacity stripper crane	To be relocated in new casting aisle
One	(1)	-	3-ton capacity lime bucket crane	
Two	(2)	-	3-ton capacity mono-rail trolley	
One	(1)	-	12.5-ton capacity overhead crane in bottom preparation aisle	
One	(1)	-	20-ton capacity overhead crane in blower plant	
One	(1)	-	25/5-ton ladle crane for electric furnace	
One	(1)	-	16/3-ton electric furnace charging crane	
One	(1)	-	8-ton capacity magnet crane	
Two	(2)	-	Lime shaft kiln and auxiliaries.	

Appendix 4-10

ALTERNATIVE 5 - LIST OF MAJOR NEW FACILITIES

			Equipment
Four	(4)	-	28-ton capacity side blown converter and accessories
Ten	(10)	-	Bottom for side blown converter
One	(1)	-	30-ton capacity platform scale for mixer
Four	(4)	-	Self-propelled transfer car for 30-ton ladle
Four	(4)	-	30-ton capacity hot metal charging ladle
Fifteen	(15)	-	30-ton capacity steel ladle
One	(1)	-	Stopper rod oven
Three	(3)	-	Ladle drier
Two	(2)	-	Ladle stand
One	(1)	-	Ladle relining pit
Two	(2)	-	Mould transfer car
Five	(5)	-	Flat car for slag pot
Twelve	(12)	-	1.5 cu m capacity lime bucket
Ten	(10)	-	Ingot car
One	(1)	-	High pressure centrifugal pump for hydraulic plant
One	(1)	-	Air blower for supplying air blast
Two	(2)	-	50/10-ton capacity teeming crane
Two	(2)	-	25-ton capacity dolomite shaft kiln and auxiliaries
		-	Dolomite preparation facilities complete with crusher, feeder, screen etc
		-	Tar storage and heating installation
One	(1)	-	Brick press for tar dolomite bricks

Appendix 6-1

STRUCTURAL STEELWORK FEATURES OF THE EXISTING STEELMELT SHOP

Construction features

The roofing is made by means of prestressed concrete slabs and a cover for sun protection.

Within the reach of the convertor from support 3 to support 9 an additional covering with 3 mm plating will be applied. Ventilation is by ventilation superstructures with side louvres.

Ventilation for the hydraulic power plant is through hand operated air casements at one side wall and one end wall.

The sections of the gutters and down-pipes are based on European conditions.

In line E of the mixer and foundry bay as well as in line C from 1 to 9 of the lime and convertor bays, the gutters are walkable and have hand railing.

The platforms in the dolomite aisle are constructed with 6/8 mm thick chequered plate flooring.

The gutters are made of plate of 6 mm thickness. The remaining gutters are made of galvanised steel sheet of 1.5 mm thickness. For carrying away the convertor dust, two stationary dust ducts of [illegible] mm dia are envisaged for each converter, and are led down to [illegible] m above floor for direct transport. No separate gates are provided. All side and end walls receive a 12 cm thick brick lining up to 3 m above floor, from 3 to 5 m a 12 cm thick perforated brickwork.

The long side wall, towards the road, has from 5 m up to the eaves vertically arranged windows with T-bars for glazing with putty with intermediate wall strips. Opposite the convertors, between supports 4 and 8, there are no windows. The other walls are open from 5 m up. The power and water plant is completely enclosed up to 5 m above floor with 12 cm brickwork and above windows with ventilation casements.

Appendix 6-1 (continued)

The convertor and mixer platforms are rammed with concrete between steel beams, covered by 20 mm gauge plates on a 30 mm thick layer of sand. Stack platform as well as scrap and lime platforms are covered with 15 m gauge plate. The stacks receive a facing of graphite chamotte plates, the convertor platform is arranged for 4 convertors including stands and plates of skull remover.

Design features

The structural steelwork is designed to German Standard Specifications, no snow load being taken into account. The material used is St. 37 structural steel.

Assumed loads

Roofing: Prestressed concrete slabs and double layer of tar paper = 140 kgs/m^2.

Within the reach of the convertor from column 3 to 10; dust load = 120 kgs/m^2.

In the other areas load of air borne sand = 50 kgs/m^2.

Platform loadings

Convertor and mixer platform	..	2 000 kgs/m^2
Stack platform	..	1 500 kgs/m^2
Lime and scrap platform	..	1 500 kgs/m^2

Weights of components

Main steelwork

All structural steelwork in the buildings excluding floor plates for the convertor and mixer platform and convertor stacks and including

i) three bins of 5 m^3 capacity each, for convertor lime
ii) three dust bins under the stack frames
iii) five bins of 6.5 m^3 capacity each
iv) two bins for the dolomite preparation of 16 m^3 capacity each
v) six dust nozzles
vi) nine bin grids 2 x 2 m
vii) two bins on the charging platform of dolomite furnace and
viii) other sundry bins of 3 085 tons approximate weight.

Appendix 6-1 (continued)

Accessories

1 200 m^2 floor plates for converter and mixer platform 20 mm thick, approximate size 800 m^2 (without boring) 190 tons.

1 140 m^2 graphite chamotte plates for 3 converter stacks, finished (including fastening materials) 122 tons.

2 660 m^2 galvanised louvre plates, 1.5 mm thick, 330 mm girth 10.4 tons.

270 m walkable gutters of 6 mm plate, 1 000 mm girth (excluding railing) 13.5 tons.

190 m length box gutter of galvanised sheet 1.5 mm thick 700 mm girth 2.3 tons.

689 m galvanised down-pipes 150 mm diameter 1.25 mm thick including elbows 6.8 tons.

50 cast iron stand pipes 150 mm diameter 1.5 m long, 2.3 tons.

20 ventilation leaves with group locking 0.7 ton.

12 two-leaf sliding gates 4 x 5 m of plain sheet with totally enclosed box section frame 10.8 tons.

8 doors 1 x 2 m of plain sheet otherwise as above 0.72 tons.

altogether 14 hand operated bin gates, i.e. 3 gates for 3 dust bins, 4 gates for 4 bins in the lime bay, 7 gates for 7 bins for the dolomite preparation 7.02 tons.

Appendix 7-1

SALVAGE VALUE OF DISCARDED EQUIPMENT AND BUILDINGS
(all values in $)

	Alt. 1	Alt. 2	Alt. 3	Alt. 4	Alt. 5
Cost of discarded equipment installed in 1958					
Mixer weighscale ..	-	-	-	-	-
Jack car ..	-	-	-	-	-
Steel casting ladles ..	51 710	-	51 710	51 710	51 710
Four 17-ton hot metal ladles ..	74 865	-	74 865	74 865	74 865
Bottom pouring ladles and plates ..	33 508	-	33 508	33 508	33 508
Two arc furnaces ..	(2 761 (629 329	-	(2 761 (629 329	(2 761 (629 329	-
Supplementary equipment ..	38 762	-	38 762	38 762	-
Shear for scrap ..	4 662	-	-	-	4 662
Scrap basket car ..	33 638	-	-	-	33 638
25/5-ton electric furnace teeming crane	48 364	-	48 364	48 364	-
16/3-ton ladle transfer crane ..	40 864	-	40 864	40 864	40 864
20-ton blower house crane ..	62 120	-	-	62 120	-
Total 1958 installed cost ..	1 020 583	-	920 163	982 283	239 247
Total written-down value at end of 1974 ..	153 087	-	138 024	147 342	35 887
Estimated salvage value @ 50% of written-down value ..	76 544	-	69 012	73 671	17 944
Other discarded equipment[a] ..	30 290 (520)	1 748 (30)	29 707 (510)	3 495 (60)	29 708 (510)
Discarded structural steelwork[b] ..	98 298 (1 350)	2 185 (30)	10 194 (1 400)	7 281 (100)	116 500 (1 600)
Total salvage value ..	205 132	3 933	108 913	84 447	164 152

a/ Calculated at the rate of $ 58.25 per ton for the estimated tonnage of melting scrap shown in brackets.

b/ Calculated at the rate of $ 58.25 per ton for the melting scrap and $ 87.38 per ton for the re-rollable scrap, assuming equal proportions of the melting and re-rollable scrap in the estimated tonnage shown in brackets.

Appendix 7-2

CURRENT RATES OF IMPORT DUTIES

Item		Rate of import duty on the c.i.f. value Individual %	Total[a/] %
1. General mechanical equipment	..	2	17
2. Pumps and air compressors	..	10	25
3. Laboratory apparatus	..	10	25
4. Telephone system	..	15	30
5. Cranes	..	20	35
6. Electrical transformers	..	20	35
7. Electrical tools	..	20	35
8. Electrical cables	..	40	55
9. Electrical equipment	..	100	115

a/ Includes additional regulatory, local government and surcharge duties of 10 per cent and 2 per cent respectively.

Appendix 7-3

PREVAILING ERECTION RATES FOR TYPICAL EQUIPMENT ITEMS

		$/ton
1.	Equipment in one piece	90.87
2.	Electric motors	90.87
3.	Equipment requiring assembly	158.44
4.	Transport and lifting equipment	163.10
5.	Reheating furnaces, heat treatment and forging furnaces	158.44
6.	Equipment for steam, ventilation etc.. ..	158.44
7.	Pumping equipment	279.60
8.	Internal piping (pipes, valves, expansion joints, filters, supports, clamps etc)	507.94
9.	Electrical equipment, cables etc for power distribution, wires and necessary fittings (whether imported or locally made) but excluding motors	500.96
10.	Piping network between different shops including the pipes together with accessories like valves, expansion joints etc[a]	93.20
11.	Supply of supports, clamps etc which are necessary for fixing pipes, cables etc	512.60
12.	Painting of the equipment including cleaning, removal of dust, corrosion and painting lead oxide and oil painting for all mechanical and electrical equipment, overhead cranes, pipes, conduits etc (including supply of necessary scaffolds) ..	
	Surface of mechanical and electrical equipment	0.93
	Overhead cranes	0.70[b]
	Pipes and ventilation network	0.70[b]

a/ Including the excavation and refilling upto 2 m depth and removal of excavation work and wrapping of pipes (steel pipes burried underground will be coated with 2 coats of paint and wrapped in 2 layers of jute and immersed in bitumen)

b/ These are the rates in $ per sq m.

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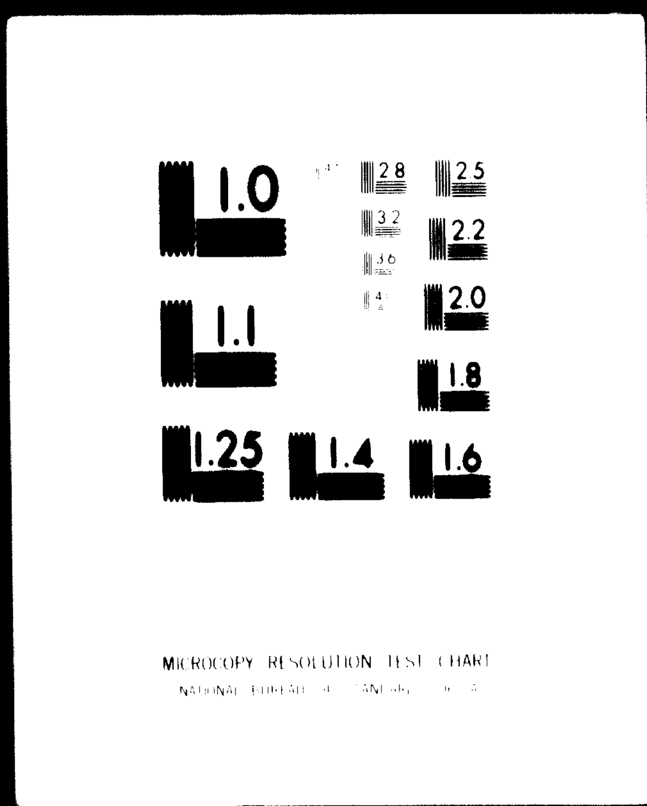

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Appendix 7-4

CONTINUING CASH EXPENSES UNDER SHUT-DOWN CONDITIONS
(all values in $/yr)

Section		Wages			Insurance	Overheads	Corresponding expenses for repair and maintenance a/	Total
	Actual	Bonus	Social benefits	Sub-total				
Thomas converter ..	112 413	4 599	39 321	156 333	3 383	80 965	28 618	269 299
Mixer section ..	9 341	298	3 269	12 908	522	6 727	6 520	26 677
Lime kiln ..	2 332	426	8 150	10 908	527	16 785	2 984	31 202
Dolomite preparations								
Calcining ..	21 145	1 866	7 398	30 409	137	15 229	4 305	50 080
Mixing ..	14 969	1 386	5 233	21 578	405	10 774	1 717	34 474
Bricks ..	11 561	1 177	4 045	16 783	21	8 327	2 008	27 139
Bottoms for Thomas converter ..	13 707	1 356	4 793	19 856	54	9 872	1 640	31 422
Sub-total ..	61 372	5 785	21 469	88 626	617	44 202	9 670	143 115
Fertiliser plant ..	22 468	715	7 859	31 042	706	16 182	3 766	51 696
Total without fertiliser plant	185 458	11 108	72 209	268 775	5 049	148 677	47 792	470 293
Total ..	207 926	11 823	80 068	299 817	5 755	164 859	51 558	521 989

a/ Assumed at 10 per cent of the total cost of repair and maintenance.

PRELIMINARY CAPITAL COST ES
(in '000 $)

Basis:		Alt. 1			Alt. 2			
		Three 20-ton LD converters (two operating)a/			Four existing Thomas converters (two operating)b/			con
		Foreign currency	Local currency	Total	Foreign currency	Local currency	Total	For cur
A. DISMANTLING WORK	..	-	-1	-1	-	47	47	
B. RECONSTRUCTION WORK								
1. Civil work	..	-	630	630	-	432	432	
2. Structural steelwork	..	237	952	1 189	160	639	799	
C. MECHANICAL AND ELECTRICAL EQUIPMENT								
1. Steelmaking equipment and plant and process auxiliaries	..	1 343	3 372	4 715	576	259	835	
2. Material handling equipment	..	50	568	618	-	503	503	
3. Services and utilities	..	2 526	1 157	3 683	282	298	580	1
4. Miscellaneous	..	-	432	432	-	214	214	
D. EQUIPMENT ERECTION	..	-	1 349	1 349	-	258	258	
E. TRANSPORT AND CUSTOMS DUTY	..							
Ocean freight and insurance - 10% of FOB equipment	..	379	-	379	86	-	86	
Clearing, rail freight, insurance etc - 3.5% of CIF value for imported equipment and 3% of local equipment	..	-	331	331	-	71	71	
Customs duty	..	-	1 115	1 115	-	257	257	
F. ENGINEERING SERVICES								
Construction supervision and engineering services	..	578	577	1 155	65	262	327	
G. PRODUCTION SHUT DOWN LOSSES	..	-	940	940	-	131	131	
H. CONTINGENCIES	..	256	576	832	58	169	227	
Total	..	5 369	11 998	17 367	1 227	3 540	4 767	1

a/ Including gas cleaning plant, 125-ton/day oxygen plant, plant and process auxiliaries etc.
b/ Including one 60-ton/day lime calcining kiln, plant and process auxiliaries.
c/ Including one 10-ton/day oxygen plant, one 30-ton/day lime calcining kiln, plant and process auxi
d/ Including one 125-ton/day oxygen plant, flux grinding facilities, plant and process auxiliaries
e/ Including two 25-ton/day dolomite shaft kilns, dolomite brick plant, plant and process auxiliarie

DASTUR ENGINEERING INTERNATIONAL GmbH
DUSSELDORF

SECTION 1

...ELIMINARY CAPITAL COST ESTIMATES
(in '000 $)

Alt. 2 ... existing Thomas ...ers (two operating)b/			Alt. 3 Four 24-ton Thomas converters (two operating)a/			Alt. 4 Three 22-ton Q-BOP converters (two operating)d/			Alt. 5 Four 28-ton Side-blown converters (two operating)a/		
...n ...cy	Local currency	Total	Foreign currency	Local currency	Total	Foreign currency	Local currency	Total	Foreign currency	Local currency	Total
-	47	47	-	103	103	-	-29	-29	-	57	57
-	432	432	-	554	554	-	478	478	-	559	559
...60	639	799	266	1 075	1 341	140	556	696	270	1 078	1 348
...76	259	835	705	252	957	260	235	495	1 145	279	1 424
-	503	503	9	554	563	9	493	502	-	504	504
82	298	580	1 253	356	1 609	2 535	323	2 858	398	353	751
-	214	214	-	432	432	-	432	432	-	432	432
-	258	258	-	411	411	-	806	806	-	345	345
...86	-	86	198	-	198	281	-	281	154	-	154
-	71	71	-	123	123	-	146	146	-	106	106
-	257	257	-	572	572	-	794	794	-	452	452
65	262	327	275	274	549	299	298	597	246	245	491
-	131	131	-	1 001	1 001	-	157	157	-	940	940
58	169	227	135	286	421	176	235	411	111	267	378
1 227	3 540	4 767	1 843	5 991	8 834	3 700	4 924	8 624	2 324	5 617	7 941

...rocess auxiliaries etc.
...liaries.
... kiln, plant and process auxiliaries etc.
...ant and process auxiliaries etc.
..., plant and process auxiliaries etc.

SECTION 2

Appendix 7-6

INTEREST ON CAPITAL DURING CONSTRUCTION a/
(in '000 $)

	Half-year period	Finance required by way of loan	Outstanding interest on long-term loan	Total loan and interest as at ½ year end	Capitalised interest
Alt. 1	1	303	-	303	10
	2	1 174	10	1 487	48
	3	741	58	2 276	74
	4	9 447	132	11 797	383
	5	4 212	515	16 392	533
	6	1 490	1 048	18 415	598
Total ..		17 367			1 646
Alt. 2	1	454	-	454	15
	2	631	15	1 100	36
	3	2 231	51	3 367	109
	4	1 077	160	4 553	148
	5	374 b/	-	-	-
Total ..		4 767			308
Alt. 3	1	144	-	144	5
	2	461	5	610	20
	3	810	25	1 440	47
	4	4 285	72	5 772	188
	5	2 214	260	8 174	266
	6	920	526	9 360	364
Total ..		8 854			890
Alt. 4	1	840	-	840	27
	2	960	27	1 827	59
	3	4 214	96	6 010	195
	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]

SECTION 1

	5	374 b/	-	-	-
Total ..		4 767			308
Alt. 3	1	144	-	144	5
	2	461	5	610	20
	3	810	25	1 440	47
	4	4 285	72	5 772	188
	5	2 214	260	8 174	266
	6	980	526	9 360	304
Total ..		8 854			830
Alt. 4	1	840	-	840	27
	2	980	27	1 [illegible]	59
	3	4 214	86	6 020	196
	4	2 104	201	8 309	270
	5	586 b/	-	-	-
Total ..		8 624			551
Alt. 5	1	129	-	129	4
	2	405	4	536	17
	3	759	21	1 292	42
	4	3 780	65	5 114	166
	5	2 025	229	7 305	237
	6	985	466	8 407	275
Total ..		7 941			759

a/ Calculated at the rate of 6.5 per cent per annum payable half-yearly.
b/ The interest is chargeable to profit and loss account and not capitalised as this is the production year.

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SECTION 2

Appendix 7-7

ESCALATION TRENDS IN REPLACEMENT COSTS OF STEELWORKS

Year		Index of replacement costs of steelworks		
		General machinery 1963 = 100	UK steelworks 1945 = 100	Indian steelworks 1938 = 100
1953	..	85	184	297
1954	..	85	191	...
1955	..	84	203	...
1956	..	88	220	...
1957	..	91	236	...
1958	..	94	240	396
1959	..	96	243	...
1960	..	97	251	...
1961	..	98	263	...
1962	..	99	270	...
1963	..	100	275	451
1964	..	101	284	...
1965	..	104	299	...
1966	..	105	311	...
1967	..	108	315	...
1968	..	110	325	531
1969	..	112	339	...

Sources:

1) General machinery - Unit value index of exports from developed market economies to developing market economies, Statistical Yearbook, 1970 United Nations

2) UK Steelworks - composite index covering blast furnaces, sinter plant, open hearth furnaces, rolling mills, coke ovens, cranes and light railway equipment as well as an element to represent industry building costs; Changes in the Replacement Cost of Industrial Assets - The Economist Intelligence Unit Ltd, London.

3) The Tata Iron and Steel Co Ltd., India - Steelmelt shop index only.

Appendix 8-1

PRESENT SECTION-WISE MANNING OF STEELMELT SHOP

Description		Grade 1	2	3	4	5	6	7	8	9	10	Total
Management												
Engineers	..	1	1	3	3	2	2	11	-	-	-	23
Secretary	..	-	-	-	-	3	3	4	2	2	-	14
Supervision	..	-	-	-	1	-	1	2	1	-	-	5
Services (unskilled workers)	..	-	-	-	-	-	-	-	-	2	6	8
Thomas shop												
Mixer	..	-	-	-	-	-	-	3	4	1	7	15
Lime bunkers	..	-	-	-	-	-	-	-	-	5	9	14
Spiegel furnace	..	-	-	-	-	-	-	2	2	-	1	5
Thomas converters	..	-	-	-	2	6	4	4	19	22	30	87
Casting bay	..	-	-	-	-	2	3	3	4	6	16	34
Ladle shop	..	-	-	-	-	-	2	3	5	5	23	38
Fertiliser	..	-	-	-	-	1	1	6	11	4	24	47
Cranes	..	-	-	-	-	-	3	12	23	25	6	69
Electric furnaces												
Electric furnaces	..	-	-	-	-	5	4	6	7	11	21	54
Casting bay	..	-	-	-	-	-	-	4	9	8	18	39
Refractories												
Dolomite	..	-	-	-	1	4	3	-	-	-	-	8
Dolomite calcining	..	-	-	-	-	-	-	2	8	7	22	39
Dolomite mixing	..	-	-	-	-	-	-	5	11	14	21	51
Converter lining	..	-	-	-	-	-	-	-	10	14	19	43
Ladle lining and furnaces	..	-	-	-	1	3	4	25	10	9	23	75
Lime calcining plant		-	-	-	-	1	4	3	3	1	41	53
Technical services												
Supplies	..	-	-	-	-	1	-	4	6	1	14	26
Services	..	-	-	-	-	-	2	4	-	6	16	28
Scrap	..	-	-	-	-	-	1	1	6	7	6	21
Mechanical maintenance	..	-	-	-	1	-	9	17	21	43	30	121
Electrical maintenance	..	-	-	-	1	2	3	13	14	7	4	44
Sub-total	..											961
Miscellaneous	..											105
Total	..											1,066

Appendix 6-2

PRESENT STEELMELT SHOP MANNING ACCORDING TO SKILLS AND TRADES

Skills and trades		Strength as on 1/7/1971
Management		
Manager	..	1
Chief engineer	..	-
Refractories chief engineer	..	1
Sub-total	..	2
Administrators and supervision		
Production senior chief	..	1
Production deputy chief	..	2
Division chief	..	2
Senior shift chief	..	4
Second shift chief	..	7
Chief foreman	..	2
Senior foreman	..	19
Assistant foreman	..	46
Assistant office chief	..	1
Assistant foreman	..	21
Chargeman	..	12
Sub-total	..	120
Technicians		
Refractories specialist	..	1
Senior engineer	..	2
Assistant senior engineer	..	2
Junior engineer	..	13
Junior specialist	..	4
Sub-total	..	22
Skilled workers		35
Senior operator	..	1
Plumber - grade 1	..	2
Senior converter builder	..	27
Senior builder	..	13
Machine operators - gr. 1	..	

Appendix 8-2 (continued)

Skills and trades		Strength as on 1/7/1971
Skilled workers (cont'd)		
Mechanic - grade 1	..	7
Fitter - grade 1	..	2
Casting car driver	..	8
Senior crane driver	..	5
Welder - grade 1	..	1
Electrician - grade 1	..	4
Converter worker	..	20
Converter operator	..	12
Senior operator (b)	..	40
Refractories operator	..	28
Mechanic	..	30
Operator	..	5
Plumber	..	4
Machine operators	..	6
Electrician	..	16
Welder	..	2
Turner	..	1
Crane driver	..	31
Fitter	..	1
Blacksmith	..	2
Sub-total	..	303
Workers		
Operator (b)	..	36
Operator (a)	..	86
Assistant builder	..	4
Blacksmith	..	12
Plumber	..	1
Machine operators	..	12
Mechanic	..	24
Fitter	..	18
Electrician	..	11
Welder	..	11
Turner	..	2
Crane driver - gr. 3	..	38
Planer	..	3
Tinner	..	1
Labour In-charge	..	-
Operator assistant	..	130
Labourer	..	34

Appendix 8-2 (continued)

Skills and trades		Strength as on 1/9/1971
Workers (cont'd)		
Worker	..	90
Assistant plumber	..	8
Assistant mechanic	..	6
Assistant blacksmith	..	2
Lubricator	..	26
Storesman	..	4
Assistant welder	..	1
Assistant electrician	..	3
Labourer	..	44
Sub-total	..	612
Clerks		
Statistician assistant	..	4
Secretary	..	1
Storekeeper	..	1
Senior clerk	..	4
Storekeeper assistant	..	2
Clerks	..	2
Sub-total		14
Total	..	1 072

OPERATING COST ESTIMATES PER TON OF INGO

Product	Alt. 1 Ingot from LD converters		Alt. 2 Ingot from Thomas converters		Alt. 3 Ingot from Thomas converters		In
Annual production, tons	380,000		330,000		380,000		
	Consumption kg/ton	Cost $/ton	Consumption kg/ton	Cost $/ton	Consumption kg/ton	Cost $/ton	Con k
MATERIAL COST							
Hot metal ..	980	46.81	1 160	58.39	1 000	50.33	
Scrap ..	147	7.92	-	-	147	7.92	
Iron oxide ..	22	0.28	6	0.08	10	0.13	
Ferro-alloys ..	21	5.96	21	5.96	21	5.96	
Fluxes and additions ..		1.89		2.87		2.19	
Total materials ..		62.86		67.30		66.53	
Less credit ..		2.17		3.03		2.98	
NET MATERIALS ..		60.69		64.27		63.55	
COST ABOVE MATERIALS							
Labour and supervision		1.56		1.93		1.89	
Oxygen ..	30 cu m	1.62	-	-	17 cu m	0.46	
Graphite electrodes ..	-	-	-	-	-	-	
Air blast ..	-	-	-	0.54	-	0.26	
Power ..	-	1.17	-	1.84	-	1.94	
Utilities and services	-	0.43	-	0.25	-	0.25	
Transport, laboratory..		1.12		1.12		1.12	
Refractories ..		1.72		5.59		5.13	
Other consumables ..		6.76		6.76		6.76	
Repair and maintenance		2.10		2.34		1.90	
Stores, lubricants etc		1.50		0.93		0.93	
General plant expenses		1.17		1.40		1.40	
TOTAL COST ABOVE MATERIALS		19.15		22.70		22.04	
WORKS COST ..		79.84		86.97		85.59	

DASTUR ENGINEERING INTERNATIONAL GmbH
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SECTION 1

...ERATING COST ESTIMATES PER TON OF INGOT

...Thomas ...s ...)	Alt. 3 Ingot from Thomas converters 380,000		Alt. 4 Ingot from OBM converters 380,000		Alt. 5 Ingot from Side blown converters 330,000		Alt. 2 and 5 Ingot from electric furnace 50,000	
Cost $/ton	Consumption kg/ton	Cost $/ton	Consumption kg/ton	Cost $/ton	Consumption kg/ton	Cost $/ton	Consumption kg/ton	Cost $/ton
58,39	1 000	50,33	975	46,57	1 165	55,64	-	-
-	147	7,92	147	7,92	-	-	1 120	60,16
0,08	10	0,13	21	0,27	1	0,02	41	0,53
5,96	21	5,96	21	5,96	21	5,96	9	2,34
2,87		2,19		1,89		1,70		[illegible]
67,30		66,53		62,61		63,32		64,37
3,03		[illegible]		2,17		2,12		2,28
64,27		63,55		60,44		61,20		62,09
1,98		1,80		1,49		1,75		2,80
-	17 cu m	0,46	59 cu m	1,59	-	-	-	-
-	-	-	-	-	-	-	7	4,35
0,54	-	0,26	-	-	-	1,05	-	-
1,84	-	1,94	-	1,28	-	1,61	-	9,44
0,25	-	0,25	-	0,82	-	0,25	-	0,31
1,12		1,12		1,12		1,12		2,38
5,59		5,13		1,80		10,25		5,88
6,76		6,76		6,76		6,76		12,23
2,34		1,90		2,00		1,90		2,00
0,93		0,98		1,00		0,95		0,35
1,40		1,40		1,17		1,28		2,10
22,70		22,04		19,08		26,90		42,32
86,97		[illegible]		79,47		88,10		104,41

SECTION 2

ANNUAL OPERATING COSTS DURING TRANSITION P
(All values in '000 $)

	Unit	Alt. 1			Alt. 2			
		LD converters	Electric furnaces	Total	Thomas converters (existing)	Electric furnaces	Total	24-ton Thomas converters
Unit variable operating cost ..	$/ton	76.18			82.71	99.61		81.80
Annual variable operating cost ..	'000 $	28 948			27 294	4 891		31 084
Unit labour and supervision cost..	$/ton	1.56			1.93	2.80		1.89
Annual labour and supervision cost	'000 $	593		593	637	140	777	718
Annual repair and maintenance cost	'000 $	798		798	772	100	872	722
Third year								
Period of operation ..	months	-	12		10	2		1
Production								
i) Proportion of rated capacity..	per cent	-	100		100	100		80
ii) Steel ingots ..	'000 tons	-	50	50	275	50	325	25.30
Variable operating cost ..	'000 $	-	4 981	4 981	22 745	4 981	27 726	2 069
Labour and supervision ..	'000 $	-	110	110	531	110	671	60
Repair and maintenance ..	'000 $	-	100	100	613	100	713	60
Total operating cost in third year ..			5 221	5 221	23 010	5 221	29 140	2 189
Fourth year								
Production								
i) Proportion of rated capacity..	per cent	70	-		100	100		90
ii) Steel ingots ..	'000 tons	266	-	266	330	50	380	342
Variable operating cost ..	'000 $	20 261	-	20 261	27 294	4 981	32 275	27 976
Labour and supervision ..	'000 $	593	-	593	637	110	777	718
Repair and maintenance ..	'000 $	798	-	798	772	100	872	772
Total operating cost in fourth year ..		21 655		21 655	28 703	5 221	33 924	29 466
Fifth year								
Production								
i) Proportion of rated capacity..	per cent	90	-		100	100		100
ii) Steel ingots ..	'000 tons	342	-	342	330	50	380	380
Variable operating cost ..	'000 $	26 054	-	26 054	27 294	4 981	32 275	31 084
Labour and supervision ..	'000 $	593	-	593	637	110	777	718
Repair and maintenance ..	'000 $	798	-	798	772	100	872	722
Total operating cost in fifth year ..		27 445		27 445	28 703	5 221	33 924	32 524
Sixth year								
Production								
i) Proportion of rated capacity..	per cent	100	-		100	100		100
ii) Steel ingots ..	'000 tons	380	-	380	330	50	380	380
Variable operating cost ..	'000 $	28 948	-	28 948	27 294	4 981	32 275	31 084
Labour and supervision ..	'000 $	593	-	593	637	110	777	718
Repair and maintenance ..	'000 $	798	-	798	772	100	872	722
Total operating cost in sixth year ..		30 339		30 339	28 703	5 221	33 924	32 524

…PERATING COSTS DURING TRANSITION PERIOD
(All values in '000 $)

Alt. 2			Alt. 3			Alt. 4			Alt. 5		
…omas …verters …isting)	Electric furnaces	Total	24-ton Thomas converters	Electric furnaces	Total	OBM converters	Electric furnaces	Total	Side-blown converters	Electric furnaces	Total
…32,71	99,61		81,80			75,98			84,47	99,61	
… 294	4 891		31 084			28 872			27 869	4 981	
1,93	2,80		1,89			1,49			1,75	2,80	
637	140	777	718		718	566		566	577	140	717
772	100	872	722		722	760		760	627	100	727
10	2		1	11		9	3		-	12	
100	100		80	100		60	100		-	100	
275	50	325	25,30	45,83	71,13	171	12,50	183,50	-	50	50
2 745	4 981	27 726	2 069	4 565	6 634	13 000	1 245	14 245	-	4 981	4 981
531	140	671	60	128	188	425	35	460	-	140	140
643	100	743	60	92	152	570	25	595	-	100	100
…3 919	5 221	29 140	2 189	4 785	6 974	13 995	1 305	15 300		5 221	5 221
100	100		90	-		90	-		60	100	
330	50	380	342	-	342	342	-	342	198	50	248
27 294	4 981	32 275	27 976	-	27 976	25 985	-	25 985	16 721	4 981	21 702
637	140	777	718	-	718	566	-	566	577	140	717
772	100	872	772	-	772	760	-	760	627	100	727
…8 705	5 221	33 924	29 466		29 466	27 311		27 311	17 925	5 221	23 146
100	100		100	-		100	-		90	100	
330	50	380	380	-	380	380	-	380	297	50	347
…7 294	4 981	32 275	31 084	-	31 084	28 872	-	28 872	25 082	4 981	30 063
637	140	777	718	-	718	566	-	566	577	140	717
772	100	872	722	-	722	760	-	760	627	100	727
…8 705	5 221	33 924	32 524		32 524	30 198		30 198	26 286	5 221	31 507
100	100		100	-		100	-		100	100	
330	50	380	380	-	380	380	-	380	330	50	380
27 294	4 981	32 275	31 084	-	31 084	28 872	-	28 872	27 869	4 981	32 850
637	140	777	718	-	718	566	-	566	577	140	717
772	100	872	722	-	722	760	-	760	627	100	727
…8 705	5 221	33 924	32 524		32 524	30 198		30 198	29 073	5 221	34 294

SECTION 2

SECTION 1

Appendix 9-1

OPERATING COST ESTIMATE FOR THE EXISTING STEELMELT SHOP WITH BAHARIYA ORE[a]

A - DERIVATION OF UNIT OPERATING COST FOR THOMAS STEEL INGOTS

	Alternative 2[b]	Existing SMS shop with Bahariya ore	Excess of the existing SMS over Alt. 2	Basis of deviation for the existing SMS shop
Annual production, '000 tons ..	330	200	-	-
Hot metal ..	Phosphorised by rock phosphate addition	Phosphorised by rock phosphate addition	-	-
Operating costs				
Labour and supervision, $/ton..	1.95	2.80	0.87	Annual average bill for existing shop = 90% of annual labour bill for Alt. 2
$/year	636 900	-	-	
Refractories, $/ton ..	5.59	6.20	0.61	Adjusted for the reduction of heat size from 16 tons to 11.5 tons
Other consumable expenses, $/ton	6.76	7.50	0.74	
Laboratory analysis, $/ton ..	1.12	1.24	0.12	
General plant expenses, $/ton..	1.55	1.94	0.39	25% increase in the overhead charges per ton
Sub-total - varying expenses	16.95	1[illegible].68	2.73	
Other operating expenses, $/ton	70.02	70.02	-	
Total - operating expenses	36.97	[illegible]9.70	2.73	

B - COMBINED UNIT AND ANNUAL OPERATING COSTS OF THOMAS AND ELECTRIC FURNACE STEEL INGOTS

	Thomas converters	Electric furnaces	Combined total/average
Annual production			
Alternative 2, '000 tons	330	50	380
Existing SMS, '000 tons	200	50	250

Unit operating cost

General plant expenses, $/ton..	1.55	1.9[illegible]	0.39	25. incre... head charges per ton
Sub-total - varying expenses	16.95	1[illegible].68	2.73	
Other operating expenses, $/ton	70.02	70.0[illegible]	-	
Total - operating expenses	86.97	[illegible]9.70	2.73	

B - COMBINED UNIT AND ANNUAL OPERATING COSTS OF THOMAS AND ELECTRIC FURNACE STEEL INGOTS

	Thomas converters	Electric furnaces	Combined total/average
Annual production			
Alternative 2, '000 tons	330	50	380
Existing SMS, '000 tons	200	50	250
Unit operating cost			
Alternative 2, $/ton	86.97 b/	104.41 b/	89.27
Existing steelmelt shop:			
i) Using Aswan ore, $/ton	145.09 c/	113.77 c/	139.36 d/
ii) Using Bahariya ore, $/ton ..	89.70	104.41 b/	92.65
Annual operating cost			
Alternative 2, '000 $	28 702	5 222	33 924
Existing steelmelt shop:			
i) Using Aswan ore, '000 $	27 740	4 863	32 603
ii) Using Bahariya ore, '000 $ ..	17 940	5 222	23 162

a/ The unit operating cost estimate for the Thomas steel production from existing steelmelt shop with the use of Bahariya ore has been derived from the corresponding estimate for the Thomas steel production for the Alternative 2 after making suitable adjustments for the differences in the scale of operation to ensure full comparability.

b/ As per Appendix 8-3.

c/ Based on the 1970-71 cost data of HADISOLB less the provision for depreciation of equipment and ladles.

d/ Weighted average with production of 1 91 194 ingot tons from Thomas converters and 42 710 ingot tons from the electric furnaces.

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SECTION 2

ANNUAL AND UNIT COSTS OF PRODUCTION

Item of cost		Basic rate per year %	Alt. 1 Basic value '000 $	Alt. 1 Unit cost $/ton	Alt. 1 Annual cost '000 $	Alt. 2[a/] Basic value '000 $	Alt. 2[a/] Unit cost $/ton	Alt. 2[a/] Annual cost '000 $	Alt. 3 Basic value '000 $	Alt. 3 Unit cost $/ton	Alt. 3 Annual cost '000 $
Operating costs											
Cost of materials	..			60.69	23 062		63.99	24 317		63.55	24 1[illegible]
Cost above materials	..			19.15	7 277		25.28	9 607		22.01	8 [illegible]
Total operating cost	..			79.84	30 339		89.27	33 924		85.59	32 [illegible]
Fixed charges											
Depreciation of											
i) equipment and buildings provided during reconstruction	..	5	15 163[c/]	1.99	758	4 237[c/]	0.56	212	7 098[c/]	0.93	[illegible]
ii) progressive replacement of retained equipment	..	5	568[d/]	0.07	28	1 597[d/]	0.21	80	1 044[d/]	0.14	[illegible]
Amortisation of project expenses[e/]		5	3 845	0.51	192	838	0.11	42	2 566	0.34	[illegible]
Interest on working capital	..	8	7 585	1.60	607	8 481	1.79	678	8 131	1.71	[illegible]
Interest on long-term loan for											
i) fixed investment[f/]	..	6.5	19 013	3.25	1 236	5 075	0.87	330	9 664	1.65	6[illegible]
ii) progressive replacement of equipment	..	6.5	568[d/]	0.10	37	1 507[d/]	0.27	104	1 044[d/]	0.18	[illegible]
Total fixed charges	..			7.52	2 858		3.81	1 446		4.95	1 [illegible]
Total production cost	..			87.36	33 197		93.08	35 370		90.54	34 [illegible]

a/ Composite rates for ingots produced from converters and electric arc furnaces.
b/ Estimated costs with the use of Bahariya ore: Incidence of fixed charges is ignored in computing ann[illegible]
c/ Include 5 per cent contingencies over the supply and erection cost of new equipment and utilities an[illegible]
d/ The present worth of annual replacement over twenty-year period calculated at the rate of 6.5 per cen[illegible]
e/ Include costs of dismantling, construction supervision and engineering services and shut-down costs wi[illegible] construction.
f/ Include capitalised interest charges.

DASTUR ENGINEERING INTERNATIONAL GmbH
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SECTION 1

Appendix 9-2

ANNUAL AND UNIT COSTS OF PRODUCTION

Alt. 2 [a]			Alt. 3			Alt. 4			Alt. 5 [a]			Existing shop [a]/[b]		
Basic value '000 $	Unit cost $/ton	Annual cost '000 $	Basic value '000 $	Unit cost $/ton	Annual cost '000 $	Basic value '000 $	Unit cost $/ton	Annual cost '000 $	Basic value '000 $	Unit cost $/ton	Annual cost '000 $	Basic value '000 $	Unit cost $/ton	Annual cost '000 $
	63.99	24 317		63.55	24 149		60.44	22 967		61.32	23 301		63.99	15 977
	25.28	9 607		22.01	8 375		19.03	7 231		28.93	10 993		28.66	7 165
	30.27	33 924		85.59	32 524		79.47	30 198		90.25	34 294		92.65	23 162
4 237 [c]	0.56	212	7 098 [c]	0.93	355	7 862 [c]	1.03	393	6 379 [c]	0.84	319	-	-	-
1 597 [d]	0.21	80	1 044 [d]	0.14	52	828 [d]	0.11	41	1 149 [d]	0.15	57	-	-	-
838	0.11	42	2 566	0.34	128	1 312	0.17	66	2 301	0.30	115	-	-	-
8 481	1.79	678	8 131	1.71	650	7 549	1.59	604	8 574	1.81	686	-	-	-
5 075	0.87	330	9 664	1.65	628	9 175	1.57	596	8 680	1.48	564	-	-	-
1 597 [d]	0.27	104	1 044 [d]	0.18	68	828 [d]	0.14	54	1 149 [d]	0.20	75	-	-	-
	3.81	1 446		4.95	1 881		4.61	1 754		4.78	1 816		-	-
	93.08	35 370		90.54	34 405		84.08	31 952		95.03	36 110		92.65	23 162

ric arc furnaces.
red charges is ignored in computing annual production cost for existing plant.
cost of new equipment and utilities and reconstruction work.
od calculated at the rate of 6.5 per cent per annum interest.
gineering services and shut-down costs with 5 per cent contingencies added and interest on capital during

SECTION 2

Year		Discount factor	Alt. 1 Production '000 tons	Capital expenses '000 $	Operating expenses '000 $	Discounted production '000 tons	Discounted capital expenses '000 $	Discounted operating expenses '000 $
Construction period								
1	..	1,145		1 477			1 691.17	
2	..	1,070		10 188			10 901.16	
Operation period								
1 b/	..	0,935	50	5 778,1	5 221	46.75	5 402,52	4 881.
2	..	0,873	266	76,1	21 655	232,22	66.44	18 904.
3	..	0,816	342	76,1	27 145	279,07	62,10	22 395.
4	..	0,763	380	76,1	30 339	289,94	58,06	23 148.
5	..	0,713	380	76,1	30 339	270,94	54,26	21 631.
6	..	0,666	380	76,1	30 339	253,08	50,68	20 205.
7	..	0,623	380	76,1	30 339	236,74	47.41	18 301.
8	..	0,582	380	76,1	30 339	221.16	44,29	17 657.
9	..	0,544	380	76,1	30 339	206,72	41,40	16 504.
10	..	0,508	380	76,1	30 339	193,04	38,66	15 112.
11	..	0,475	380	76,1	30 339	180,50	36,15	14 411.
12	..	0,441	380	76,1	30 339	168,72	33,79	13 470.
13	..	0,415	380	76,1	30 339	157,70	31,58	12 590.
14	..	0,388	380	76,1	30 339	147,44	29,53	11 771.
15	..	0,362	380	76,1	30 339	137,56	27,55	10 982.
16	..	0,339	380	76,1	30 339	128,82	25,80	10 281.
17	..	0,317	380	76,1	30 339	120,16	24,12	9 617.
18	..	0,296	380	76,1	30 339	112,18	22,53	8 980.
19	..	0,277	380	76,1	30 339	105,26	21,08	8 103.
20 c/	..	0,258	380	76,1	30 339	98,04	19,63	7 827.
				(-)3 031			(-)782,87	
Total	..					3 586,64	17 947,04	287 973.

Total of discounted expenses - '000 $ — 305 920.16

Present worth of expenses - $/ingot ton — 85.29

a/ As the production from the existing steelmelt shop facilities can continue at 250 000 tons per annu... worth of operating expenses from the existing steelmelt would be the same as the operating cost ... for the same.
b/ This will be the third year of construction for Alternatives 1, 3 and 5.
c/ The figures with (-) sign represent the residual value of equipment at the end of twenty years.

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SECTION 1

PRESENT WORTH [illegible]
(rate [illegible]

Alt. 1				Alt. 2					
Operating expenses '000 $	Discounted production '000 tons	Discounted capital expenses '000 $	Discounted operating expenses '000 $	Production '000 tons	Capital expenses '000 $	Operating expenses '000 $	Discounted production '000 tons	Discounted capital expenses '000 $	Discounted operating expenses '000 $
		1 691.17			1 085			1 242.33	
		10 901.16			3 308			3 539.56	
5 221	46.75	5 402.52	4 881.64	325	588.1	29 140	303.71	549.87	27 245.[illegible]
21 655	232.22	66.44	18 904.82	380	214.1	33 924	331.89	186.91	29 615.[illegible]
27 145	279.07	62.10	22 395.12	380	214.1	33 924	310.16	174.71	27 681.[illegible]
30 339	289.94	58.06	25 148.66	380	214.1	33 924	289.94	163.36	25 884.[illegible]
30 339	270.94	54.26	21 631.71	380	214.1	33 924	270.94	152.65	24 187.[illegible]
30 339	253.08	50.68	20 205.77	380	214.1	33 924	253.08	142.59	22 598.[illegible]
30 339	236.74	47.41	18 301.20	380	214.1	33 924	236.74	133.38	21 134.6[illegible]
30 339	221.16	44.29	17 657.30	380	214.1	33 924	221.16	124.61	19 743.7[illegible]
30 339	206.72	41.40	16 504.42	380	214.1	33 924	206.72	116.47	18 454.[illegible]
30 339	193.04	38.66	15 412.21	380	214.1	33 924	193.04	108.76	17 233.[illegible]
30 339	180.50	36.15	14 411.05	380	214.1	33 924	180.50	101.70	16 113.[illegible]
30 339	168.72	33.79	13 470.52	380	214.1	33 924	168.72	95.06	15 062.2[illegible]
30 339	157.70	31.58	12 590.69	380	214.1	33 924	157.70	88.85	14 078.4[illegible]
30 339	147.44	29.53	11 771.53	380	214.1	33 924	147.44	83.07	13 162.51
30 339	137.56	27.55	10 982.72	380	214.1	33 924	137.56	77.50	12 280.[illegible]
30 339	128.82	25.80	10 284.92	380	214.1	33 924	128.82	72.58	11 500.2[illegible]
30 339	120.46	24.12	9 617.46	380	214.1	33 924	120.46	67.87	10 753.9[illegible]
30 339	112.18	22.53	8 980.34	380	214.1	33 924	112.48	63.37	10 041.5[illegible]
30 339	105.26	21.08	8 403.90	380	214.1	33 924	105.26	59.31	9 396.9[illegible]
30 339	98.04	19.63	7 827.46	380	214.1	33 924	98.04	55.24	8 752.[illegible]
		(-)782.87			(-)2 776			(-)716.21	
	3 586.64	17 947.04	287 973.42				3 974.36	6 683.54	354 917.[illegible]
		305 920.46						361 601.35	
		85.29						90.98	

[illegible]cilities can continue at 250 000 tons per annum throughout the twenty-year period, without reconstruction the present [illegible]melt would be the same as the operating cost i.e. $ 92.65 per ingot ton and hence separate calculations are not shown

[illegible]rnatives 1, 3 and 5.
[illegible]ue of equipment at the end of twenty years.

SECTION 2

Appendix 9-3

PRESENT WORTH OF CAPITAL AND OPERATING OUTLAYS[a/]
(rate of discount - 7 per cent)

Alt. 2				Alt. 3						
…rating expenses '000 $	Discounted production '000 tons	Discounted capital expenses '000 $	Discounted operating expenses '000 $	Production '000 tons	Capital expenses '000 $	Operating expenses '000 $	Discounted production '000 tons	Discounted capital expenses '000 $	Discounted operating expenses '000 $	Productio… '000 to…
		1 242.33			605			692.73		
		3 539.56			5 085			5 451.65		
140	303.71	549.87	27 245.90	71.1	3 245.3	6 974	66.44	3 034.36	6 520.89	183.5
3 924	331.89	186.91	29 615.65	342	140	29 466	298.70	122.22	25 723.82	342
3 924	310.16	174.71	27 681.98	380	140	32 524	310.16	114.24	26 539.58	380
3 924	289.94	163.36	25 884.01	380	140	32 524	289.94	106.82	24 815.81	380
3 924	270.94	152.65	24 187.81	380	140	32 524	270.94	99.82	23 180.61	380
3 924	253.08	142.59	22 598.38	380	140	32 524	253.08	93.24	21 660.98	380
3 924	236.74	133.38	21 134.65	380	140	32 524	236.74	87.22	20 262.15	380
3 924	221.16	124.61	19 743.77	380	140	32 524	221.16	81.48	18 928.97	380
3 924	206.72	116.47	18 454.66	380	140	32 524	206.72	76.16	17 693.06	380
3 924	193.04	108.76	17 233.39	380	140	32 524	193.04	71.12	16 522.19	380
3 924	180.50	101.70	16 113.90	380	140	32 524	180.50	66.50	15 418.90	380
3 924	168.72	95.06	15 062.26	380	140	32 524	168.72	62.16	14 410.66	380
3 924	157.70	88.85	14 078.46	380	140	32 524	157.70	58.10	13 197.46	380
3 924	147.44	83.07	13 162.51	380	140	32 524	147.44	54.32	12 619.31	380
3 924	137.56	77.50	12 280.49	380	140	32 524	137.56	50.68	11 773.69	380
3 924	128.82	72.58	11 500.24	380	140	32 524	128.82	47.46	11 025.64	380
3 924	120.46	67.87	10 753.91	380	140	32 524	120.46	44.38	10 310.11	380
3 924	112.48	63.37	10 041.50	380	140	32 524	112.48	41.41	9 627.10	380
3 924	105.26	59.31	9 396.95	380	140	32 524	105.26	38.78	9 009.15	380
33 924	98.04	55.24	8 752.39	380	140	32 524	98.04	36.12	8 391.19	380
		(-)716.21			(-)2 465			(-)635.97		
	3 974.36	6 683.54	354 917.81				3 703.90	9 895.03	318 000.37	
		361 601.35						327 895.40		
		90.98						88.52		

…period, without reconstruction the present
… hence separate calculations are not shown

SECTION 3

OPERATING OUTLAYS[a]
per cent)

Alt. 3					Alt. 4					
Capital expenses '000 $	Operating expenses '000 $	Discounted production '000 tons	Discounted capital expenses '000 $	Discounted operating expenses '000 $	Production '000 tons	Capital expenses '000 $	Operating expenses '000 $	Discounted production '000 tons	Discounted capital expenses '000 $	Discounted operating expenses '000 $
605			692.73			1 800			2 061.00	
5 085			5 451.65			6 228			6 663.96	
3 245.3	6 974	66.44	3 034.36	6 520.[illegible]9	183.5	707.3	15 300	171.57	661.33	14 305.50
140	29 466	298.70	122.22	25 723.82	342	111.3	27 311	298.57	97.16	23 842.50
140	32 524	310.16	114.24	26 539.58	380	111.3	30 198	310.08	90.82	24 641.57
140	32 524	289.94	106.82	24 815.81	380	111.3	30 198	289.94	84.92	23 041.07
140	32 524	270.94	99.82	23 189.61	380	111.3	30 198	270.94	79.36	21 531.17
140	32 524	253.08	93.24	21 660.98	380	111.3	30 198	253.08	74.13	20 111.87
140	32 524	236.74	87.22	20 262.45	380	111.3	30 198	236.74	69.34	18 813.35
140	32 524	221.16	81.48	18 928.97	380	111.3	30 198	221.16	64.78	17 575.24
140	32 524	206.72	76.16	17 693.06	380	111.3	30 198	206.72	60.55	16 [illegible]27.71
140	32 524	193.04	71.12	16 522.19	380	111.3	30 198	193.04	56.54	15 3[illegible]0.38
140	32 524	180.50	66.50	15 418.90	380	111.3	30 198	180.50	52.87	14 3[illegible].05
140	32 524	168.72	62.16	14 [illegible]10.66	380	111.3	30 198	168.72	49.42	13 407.[illegible]1
140	32 524	157.70	58.10	13 197.46	380	111.3	30 198	157.70	46.19	12 532.17
140	32 524	147.44	54.32	12 619.31	380	111.3	30 198	147.44	43.18	11 716.82
140	32 524	137.56	50.68	11 773.69	380	111.3	30 198	137.56	40.29	10 931.68
140	32 524	128.82	47.46	11 025.64	380	111.3	30 198	128.82	37.78	10 237.12
140	32 524	120.46	44.38	10 310.11	380	111.3	30 198	120.46	35.28	9 572.77
140	32 524	112.48	41.41	9 627.10	380	111.3	30 198	112.48	32.91	8 938.31
140	32 524	105.26	38.78	9 009.15	380	111.3	30 198	105.26	30.83	8 361.85
140	32 524	98.04	36.12	8 391.19	380	111.3	30 198	98.04	28.72	7 701.08
12 465			(-)635.97			(-)2 280			(-)590.56	
		3 703.90	9 895.03	318 000.37				3 808.82	9 900.78	303 467.62
			327 895.40						313 368.40	
			88.52						82.27	

SECTION 4

Alt. 4				Alt. 5					
rating expenses '000 $	Discounted production '000 tons	Discounted capital expenses '000 $	Discounted operating expenses '000 $	Production '000 tons	Capital expenses '000 $	Operating expenses '000 $	Discounted production '000 tons	Discounted capital expenses '000 $	Discounted operating expenses '000 $
		2 061.00			532			609.14	
		6 663.96			4 519			4 835.33	
300	171.57	661.33	14 305.50	50	3 144	5 221	46.73	2 939.64	4 881.64
311	298.57	97.16	23 842.50	248	154	23 146	216.60	134.44	20 206.46
198	310.08	90.82	24 641.57	347	154	31 507	283.22	125.66	25 709.71
198	289.94	84.92	23 041.07	380	154	34 294	289.86	117.50	26 166.32
198	270.94	79.36	21 531.17	380	154	34 294	270.94	109.80	24 451.62
198	253.08	74.13	20 111.87	380	154	34 294	253.08	102.56	22 839.80
198	236.74	69.34	18 813.35	380	154	34 294	236.74	95.94	21 365.16
198	221.16	64.78	17 575.24	380	154	34 294	221.16	89.63	19 959.11
198	206.72	60.55	16 427.71	380	154	34 294	206.72	83.78	18 655.94
198	193.04	56.54	15 340.58	380	154	34 294	193.04	78.23	17 421.35
198	180.50	52.87	14 344.05	380	154	34 294	180.50	73.15	16 289.65
198	168.72	49.42	13 407.01	380	154	34 294	168.72	68.38	15 226.54
198	157.70	46.19	12 532.17	380	154	34 294	157.70	63.91	14 232.01
198	147.44	43.18	11 716.82	380	154	34 294	147.44	59.75	13 306.07
198	137.56	40.29	10 931.68	380	154	34 294	137.56	55.75	12 411.43
198	128.82	37.73	10 237.12	380	154	34 294	128.82	52.21	11 625.67
198	120.46	35.28	9 572.77	380	154	34 294	120.46	48.82	10 871.20
198	112.48	32.94	8 938.61	380	154	34 294	112.48	45.58	10 151.02
198	105.26	30.83	8 364.85	380	154	34 294	105.26	42.66	9 499.44
198	98.04	28.72	7 791.08	380	154	34 294	98.04	39.73	8 847.85
		(-)590.56			(-)2 497			(-)641.23	
	3 808.82	9 900.78	305 167.82				3 575.07	9 227.36	324 120.99
		313 368.40						333 348.35	
		82.27						93.24	

SECTION 5

Appendix 9-4

COMPUTATIONS OF THE INTERNAL RATE OF RETURN
(all values in million $)

A - CASH OUTFLOW ON RECONSTRUCTION CAPI

Year	Alt. 1 Actual	Alt. 1 Compounded annually @ 10%	Alt. 1 Compounded annually @ 15%	Alt. 2 Actual	Alt. 2 Compounded annually @ 1%	Alt. 2 Compounded annually @ 7%	Alt. 3 Actual	Alt. 3 Compounded annually @ 10%	Alt. 3 Compounded annually @ 25%
Construction period									
1 ..	1.48	1.97	2.25	1.09	1.12	1.34	0.60	0.80	1.17
2 ..	10.19	12.33	13.48	3.31	3.38	3.79	5.10	6.17	7.97
3a/ ..	5.70	6.27	6.56	0.37	0.37	0.40	3.13	3.44	3.91
Total A ..	17.37	20.57	22.29	4.77	4.87	5.53	8.83	10.41	13.05

B - CASH INFLOW FROM SAVINGS

Year	Alt. 1 Actual Gross	Alt. 1 Actual Net	Alt. 1 Discounted annually @ 10%	Alt. 1 Discounted annually @ 15%	Alt. 2 Actual Gross	Alt. 2 Actual Net	Alt. 2 Discounted annually @ 1%	Alt. 2 Discounted annually @ 7%	Alt. 3 Actual Gross	Alt. 3 Actual Net	Alt. 3 Discounted annually @ 10%	Alt. 3 Discounted annually @ 25%
Operation period												
1a/ ..	(-)0.69	(-)0.77	(-)0.70	(-)0.67	0.39	0.18	0.18	0.17	(-)0.54	(-)0.68	(-)0.62	(-)0.51
2 ..	2.56	2.48	2.05	1.87	0.60	0.39	0.38	0.34	1.63	1.49	1.23	0.95
3 ..	3.69	3.61	2.71	2.38	0.60	0.39	0.38	0.32	2.03	1.89	1.42	0.97
4 ..	4.26	4.18	2.85	2.39	0.60	0.39	0.37	0.30	2.03	1.89	1.29	0.77
5 ..	4.26	4.18	2.60	2.08	0.60	0.39	0.37	0.28	2.03	1.89	1.17	0.62
6 ..	4.26	4.18	2.36	1.81	0.60	0.39	0.37	0.26	2.03	1.89	1.07	0.50
7 ..	4.26	4.18	2.14	1.57	0.60	0.39	0.36	0.24	2.03	1.89	0.97	0.40
8 ..	4.26	4.18	1.95	1.37	0.60	0.39	0.36	0.23	2.03	1.89	0.88	0.32
9 ..	4.26	4.18	1.77	1.19	0.60	0.39	0.36	0.21	2.03	1.89	0.80	0.25
10 ..	4.26	4.18	1.61	1.03	0.60	0.39	0.35	0.20	2.03	1.89	0.73	0.20
11 ..	4.26	4.18	1.46	0.90	0.60	0.39	0.35	0.19	2.03	1.89	0.66	0.16
12 ..	4.26	4.18	1.33	0.78	0.60	0.39	0.35	0.17	2.03	1.89	0.60	0.13
13 ..	4.26	4.18	1.21	0.68	0.60	0.39	0.34	0.16	2.03	1.89	0.55	0.10
14 ..	4.26	4.18	1.10	0.59	0.60	0.39	0.34	0.15	2.03	1.89	0.50	0.08
15 ..	4.26	4.18	1.00	0.51	0.60	0.39	0.34	0.14	2.03	1.89	0.45	0.07
16 ..	4.26	4.18	0.91	0.45	0.60	0.39	0.33	0.13	2.03	1.89	0.41	0.05
17 ..	4.26	4.18	0.83	0.39	0.60	0.39	0.33	0.12	2.03	1.89	0.37	0.04
18 ..	4.26	4.18	0.75	0.34	0.60	0.39	0.33	0.12	2.03	1.89	0.34	0.03
19 ..	4.26	4.18	0.69	0.29	0.60	0.39	0.32	0.11	2.03	1.89	0.31	0.03
20 ..	7.29	7.21	1.07	0.44	3.38	3.17	2.60	0.82	4.50	4.36	0.65	0.05
Total B ..	81.01		29.69	20.39	14.57		9.11	4.66	40.10		13.78	5.18
Ratio A/B ..			0.69	1.09			0.53	1.19			0.76	2.52
Rate of return c/ - per cent			14				5				12	

a/ The third year above zero point and the first year below zero point are identical.

b/ The gross savings are arrived at by multiplying the annual output with the saving on the operating cost per
operating cost from the existing steelmelt shop facilities at the present level of operations. The net sav
on the progressive replacement of retained equipment.

c/ Calculated by interpolation of the trial rates.

SECTION 1

Appendix 9-4

: OF THE INTERNAL RATE OF RETURN
:l values in million $)

	Alt. 3			Alt. 4			Alt. 5	
- CASH OUTFLOW ON RECONSTRUCTION CAPITAL EXPENSES								
ually @		Compounded annually @			Compounded annually @			Compounded annually @
7%	Actual	10%	25%	Actual	20%	30%	Actual	1%
.34	0.60	0.80	1.17	1.80	3.11	3.95	0.53	0.53
.79	5.10	6.17	7.97	6.23	8.97	10.53	4.52	4.61
.40	3.13	3.44	3.91	0.59	0.71	0.77	2.89	2.92
.53	8.83	10.41	13.06	8.62	12.79	15.25	7.94	8.08

B - CASH INFLOW FROM SAVINGS[b/]

ed @	Actual		Discounted annually @		Actual		Discounted annually @		Actual		Discounted annually @
7%	Gross	Net	10%	25%	Gross	Net	20%	30%	Gross	Net	1%
).17	(-)0.54	(-)0.68	(-)0.62	(-)0.54	1.39	1.28	1.07	0.98	(-)0.69	(-)0.84	(-)0.83
.34	1.63	1.49	1.23	0.95	3.71	3.62	2.52	2.15	(-)0.63	(-)0.78	(-)0.76
).32	2.03	1.89	1.42	0.97	4.40	4.29	2.48	1.95	0.01	(-)0.14	(-)0.14
).30	2.03	1.89	1.29	0.77	4.40	4.29	2.07	1.50	0.23	0.08	0.08
).28	2.03	1.89	1.17	0.62	4.40	4.29	1.72	1.13	0.23	0.08	
).26	2.03	1.89	1.07	0.50	4.40	4.29	1.44	0.89	0.23	0.08	
).24	2.03	1.89	0.97	0.40	4.40	4.29	1.20	0.68	0.23	0.08	
).23	2.03	1.89	0.88	0.32	4.40	4.29	1.00	0.53	0.23	0.08	
).21	2.03	1.89	0.80	0.25	4.40	4.29	0.83	0.40	0.23	0.08	
).20	2.03	1.89	0.73	0.20	4.40	4.29	0.69	0.31	0.23	0.08	
).19	2.03	1.89	0.66	0.16	4.40	4.29	0.58	0.24	0.23	0.08	
).17	2.03	1.89	0.60	0.13	4.40	4.29	0.48	0.18	0.23	0.08	
).16	2.03	1.89	0.55	0.10	4.40	4.29	0.40	0.14	0.23	0.08	
).15	2.03	1.89	0.50	0.08	4.40	4.29	0.33	0.11	0.23	0.08	
.14	2.03	1.89	0.45	0.07	4.40	4.29	0.28	0.09	0.23	0.08	
).13	2.03	1.89	0.41	0.05	4.40	4.29	0.23	0.06	0.23	0.08	
).12	2.03	1.89	0.37	0.04	4.40	4.29	0.19	0.05	0.23	0.08	
).12	2.03	1.89	0.34	0.03	4.40	4.29	0.16	0.04	0.23	0.08	
).11	2.03	1.89	0.31	0.03	4.40	4.29	0.13	0.03	0.23	0.08	
).82	4.50	4.36	0.65	0.05	6.69	6.58	0.17	0.03	2.73	2.58	
.66	40.10		13.78	5.18	86.59		17.97	11.51	5.08		
1.19			0.76	2.52			0.71	1.32			
		12				25					(-)

:ntical.
:saving on the operating cost per ingot ton of the respective alternative as compared to the
: level of operations. The net savings equal gross savings minus the annual capital expenses

SECTION 2

Appendix 9-5

PAY BACK PERIODS a/
(with 7 per cent rate of return)

A - CASH IN-FLOW FROM SAVINGS - in m[...]

Year	Alt. 1 Actual	Alt. 1 Discounted/Present value Current	Alt. 1 Discounted/Present value Cumulative	Alt. 2 Actual	Alt. 2 Discounted/Present value Current	Alt. 2 Discounted/Present value Cumulative	Actual	Di[...]
Operation period								
1 ..	(-)0.69	(-)0.65		0.39	0.36		(-)0.54	(-
2 ..	2.56	2.23	1.58	0.60	0.52	0.88	1.63	
3 ..	3.69	3.01	4.59	0.60	0.49	1.37	2.03	
4 ..	4.26	3.25	7.84	0.60	0.46	1.83	2.03	
5 ..	4.26	3.04	10.88	0.60	0.43	2.26	2.03	
6 ..	4.26	2.84	13.72	0.60	0.40	2.66	2.03	
7 ..	4.26	2.65	16.37	0.60	0.37	3.03	2.03	
8 ..	4.26	2.48	18.85	0.60	0.35	3.38	2.03	
9 ..	4.26	2.32	21.17	0.60	0.33	3.71	2.03	
10 ..	4.26	2.16		0.60	0.30	4.01	2.03	
11 ..	4.26	2.02		0.60	0.29	4.30	2.03	
12 ..	4.26	1.89		0.60	0.27	4.57	2.03	
13 ..	4.26	1.77		0.60	0.25	4.82	2.03	
14 ..	4.26	1.65		0.60	0.23	5.05	2.03	
15 ..	4.26	1.54		0.60	0.22	5.27	2.03	
16 ..	4.26	1.44		0.60	0.20	5.47	2.03	
17 ..	4.26	1.35		0.60	0.19	5.66	2.03	
18 ..	4.26	1.26		0.60	0.18	5.84	2.03	
19 ..	4.26	1.18		0.60	0.17	6.01	2.03	
20 ..	4.26	1.10		0.60	0.15	6.16	2.03	

B - CASH OUTFLOW ON RECONSTRUCTION CAPITAL EXPENSES -

	Alt. 1 Actual	Alt. 1 Compounded present value	Alt. 2 Actual	Alt. 2 Compounded present value	Actual	Co[...]
Construction period						
1 ..	1.48	1.81	1.09	1.34	0.60	
2 ..	10.19	11.67	3.31	3.79	5.10	
3 ..	5.70	6.09	0.37	0.40	3.13	
Operation period						
1 to 20 b/ ..	1.60	0.86	4.20	2.22	2.80	
Total ..		20.45		7.75		

C - PAY BACK PERIOD - years

Alt. 1	Alt. 2	
$8 + \frac{(20.45 - 18.85)}{2.32} = 8.7$ Say .. 9	About 40 years.	9 + (11.[...] 1.[...]

a/ The pay back period for the Alternative 5 has not been worked out as the internal rate of return is negativ[...]
b/ These represent cumulative capital expenses on progressive replacement of equipment for the twenty-year ope[...] their present value.

DASTUR ENGINEERING INTERNATIONAL GmbH
DUSSELDORF

SECTION 1

PAY BACK PERIODS[a]
(with 7 per cent rate of return)

I - [illegible] FROM SAVINGS - in million $

Alt. 2		Alt. 3			Alt. 4		
Discounted/Present value			Discounted/Present value			Discounted/Present value	
Current	Cumulative	Actual	Current	Cumulative	Actual	Current	Cumulative
0.36		(-)0.54	(-)0.50		1.39	1.30	
0.52	0.88	1.65	1.42	0.92	3.71	3.24	4.54
[illegible]	1.37	2.05	1.66	2.58	4.40	3.59	8.13
[illegible]	1.8[illegible]	2.05	1.55	4.13	4.40	3.36	11.49
[illegible]	2.26	2.05	1.45	5.58	4.40	3.14	
[illegible]	2.64	2.05	1.35	6.93	4.40	2.93	
[illegible]	3.0[illegible]	2.05	1.26	8.19	4.40	2.74	
[illegible]	3.3[illegible]	2.05	1.18	9.37	4.40	2.56	
[illegible]	3.71	2.05	1.10	10.47	4.40	2.39	
[illegible]	4.01	2.05	1.03	11.50	4.40	2.24	
[illegible]	4.30	2.05	0.96		4.40	2.09	
[illegible]	4.57	2.05	0.90		4.40	1.95	
[illegible]	4.82	2.05	0.84		4.40	1.83	
[illegible]	5.0[illegible]	2.05	0.79		4.40	1.71	
[illegible]	5.27	2.05	0.73		4.40	1.59	
[illegible]	5.47	2.05	0.6[illegible]		4.40	1.49	
[illegible]	5.6[illegible]	2.05	0.64		4.40	1.39	
[illegible]	5.84	2.05	0.60		4.40	1.30	
[illegible]	6.0[illegible]	2.05	0.56		4.40	1.22	
[illegible]	6.1[illegible]	2.05	0.52		4.40	1.14	

[illegible] CAPITAL EXPENSES - in million $

	Alt. 3 Actual	Alt. 3 Compounded present value	Alt. 4 Actual	Alt. 4 Compounded present value
[illegible]	0.60	0.74	1.80	2.21
[illegible]	5.10	5.85	6.23	7.13
[illegible]	3.13	3.35	0.59	0.64
[illegible]	2.80	1.48	2.20	1.16
		11.40		11.14

[illegible] PAY BACK PERIOD - years

Alt. 3: $9 + \frac{(11.40 - 10.47)}{1.05} = 9.9$

Say .. 10

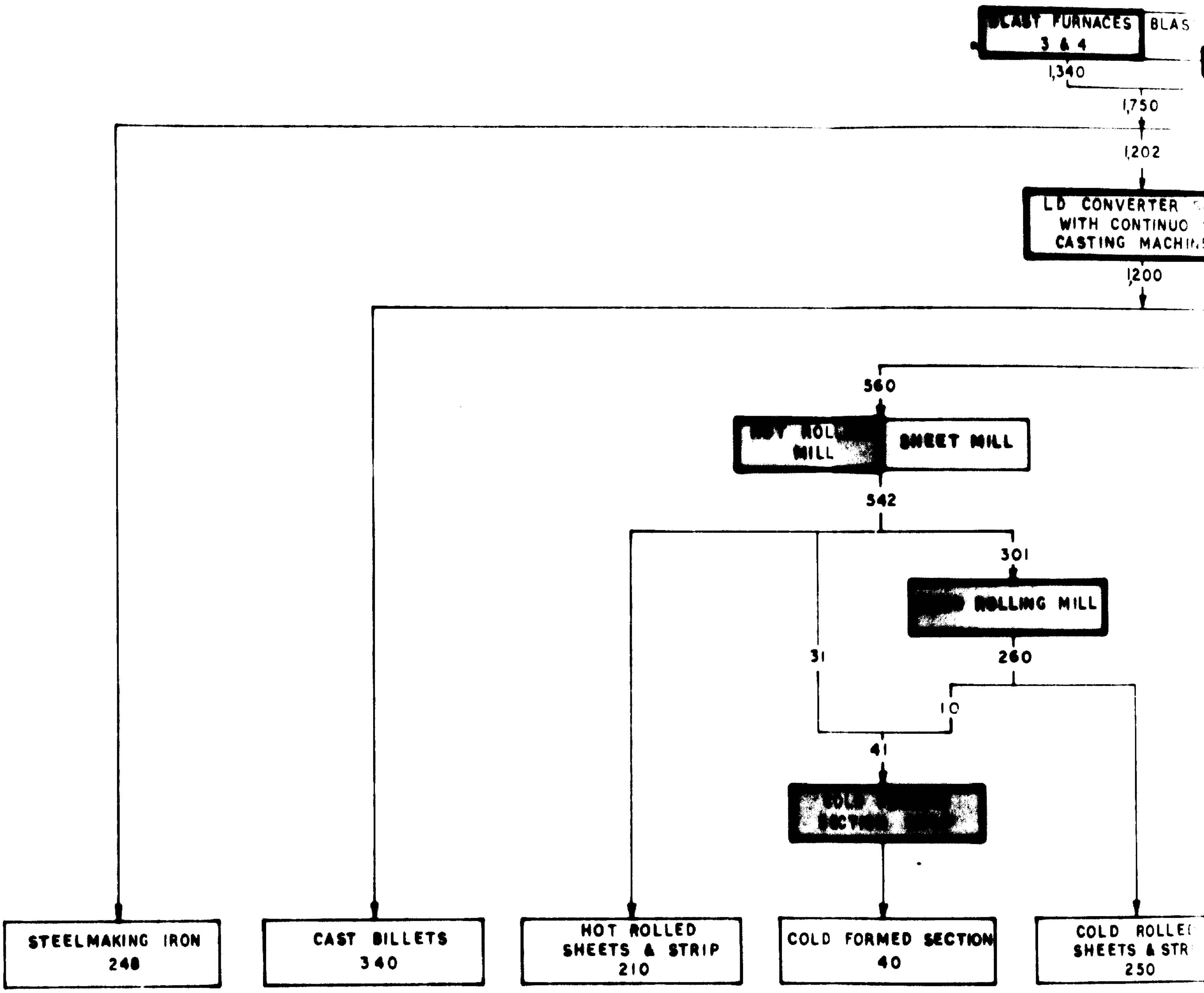
Alt. 4: $3 + \frac{(11.14 - 8.13)}{3.36} = 3.9$

Say .. 4

[illegible] internal rate of return is negative.
[illegible] of equipment for the twenty-year operation period and hence are discounted for determining

SECTION 2

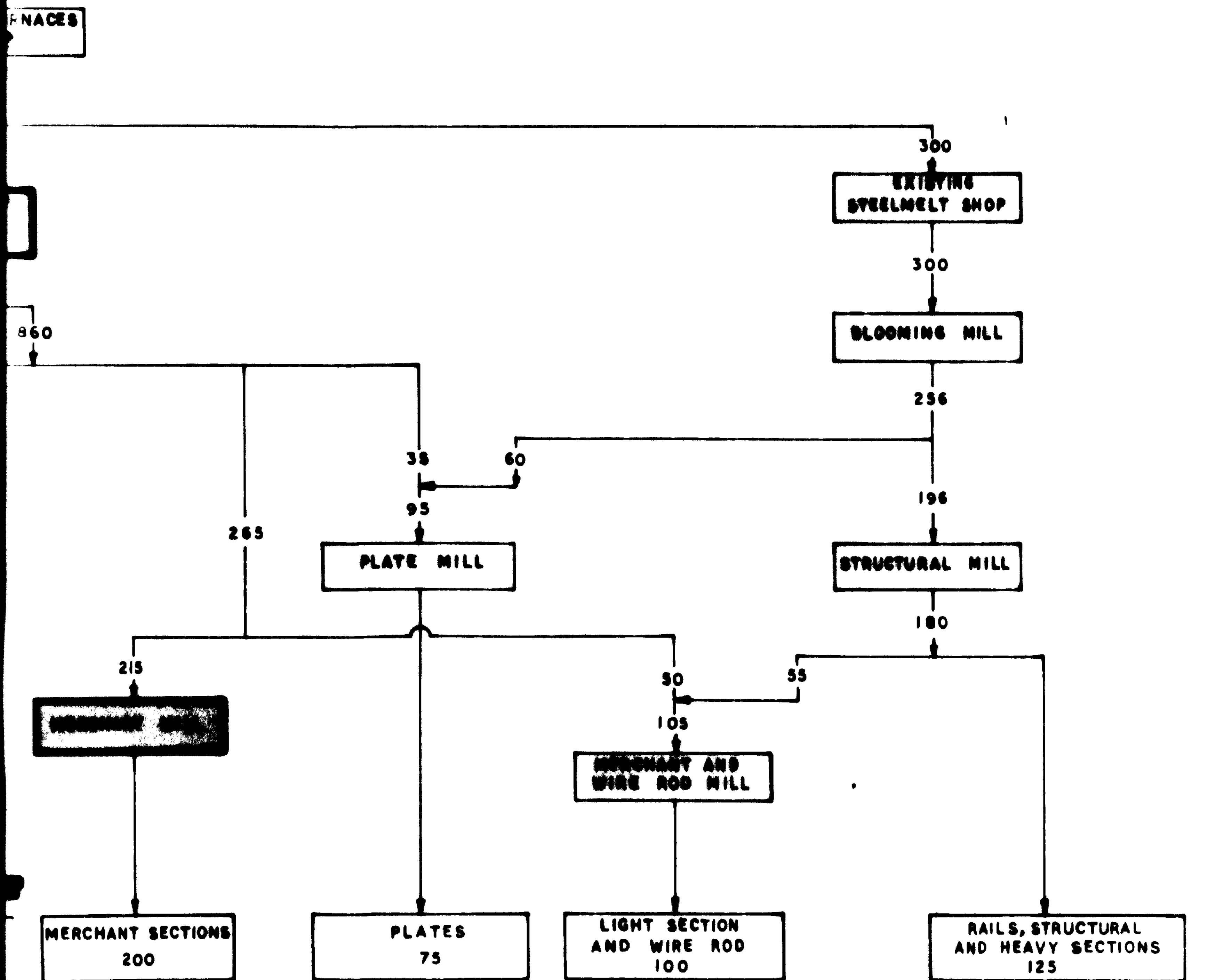
D R A W I N G S



SECTION 1

NOTE:

QUANTITIES IN THOUSAND TONS PER YEAR UNLESS OTHERWISE SPECIFIED



NEW FACILITIES

EXISTING FACILITIES

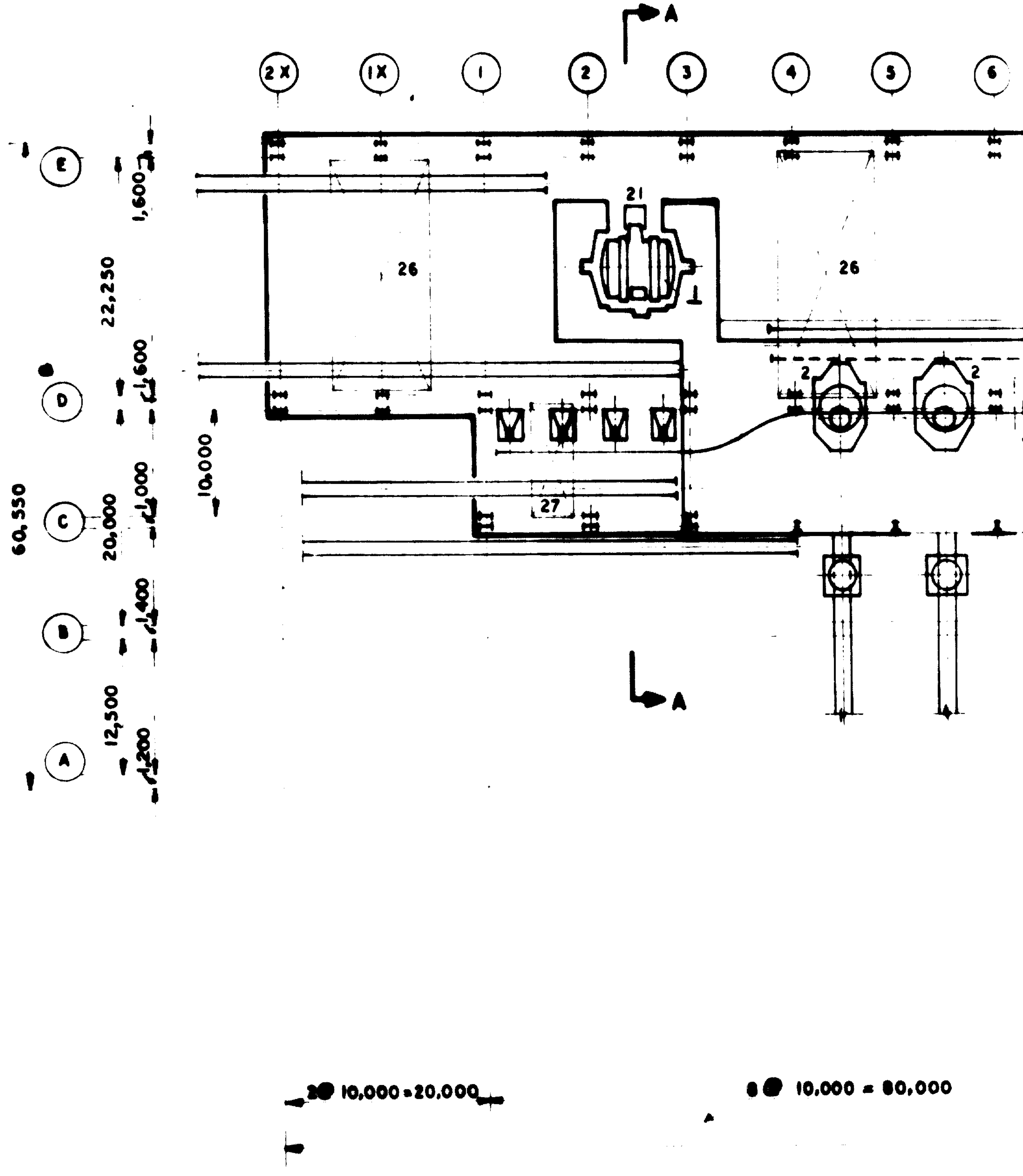
SECTION 2

DASTUR ENGINEERING INTERNATIONAL GmbH
CONSULTING ENGINEERS, DÜSSELDORF

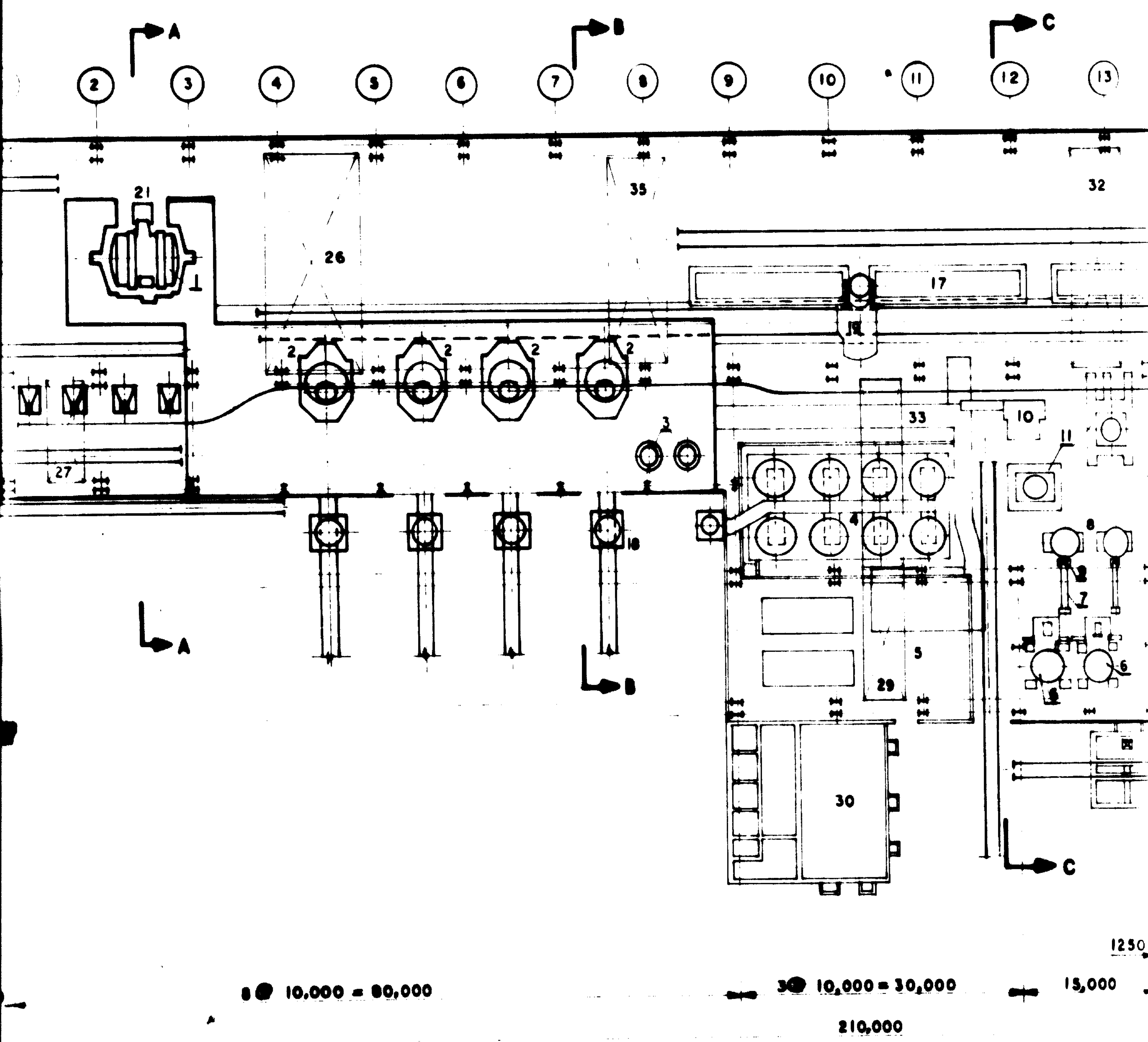
FOR: UNITED NATIONS
INDUSTRIAL DEVELOPMENT ORGANIZATION

HELWAN IRON & STEEL PLANT
EXPANSION PROGRAMME – FLOW SHEET

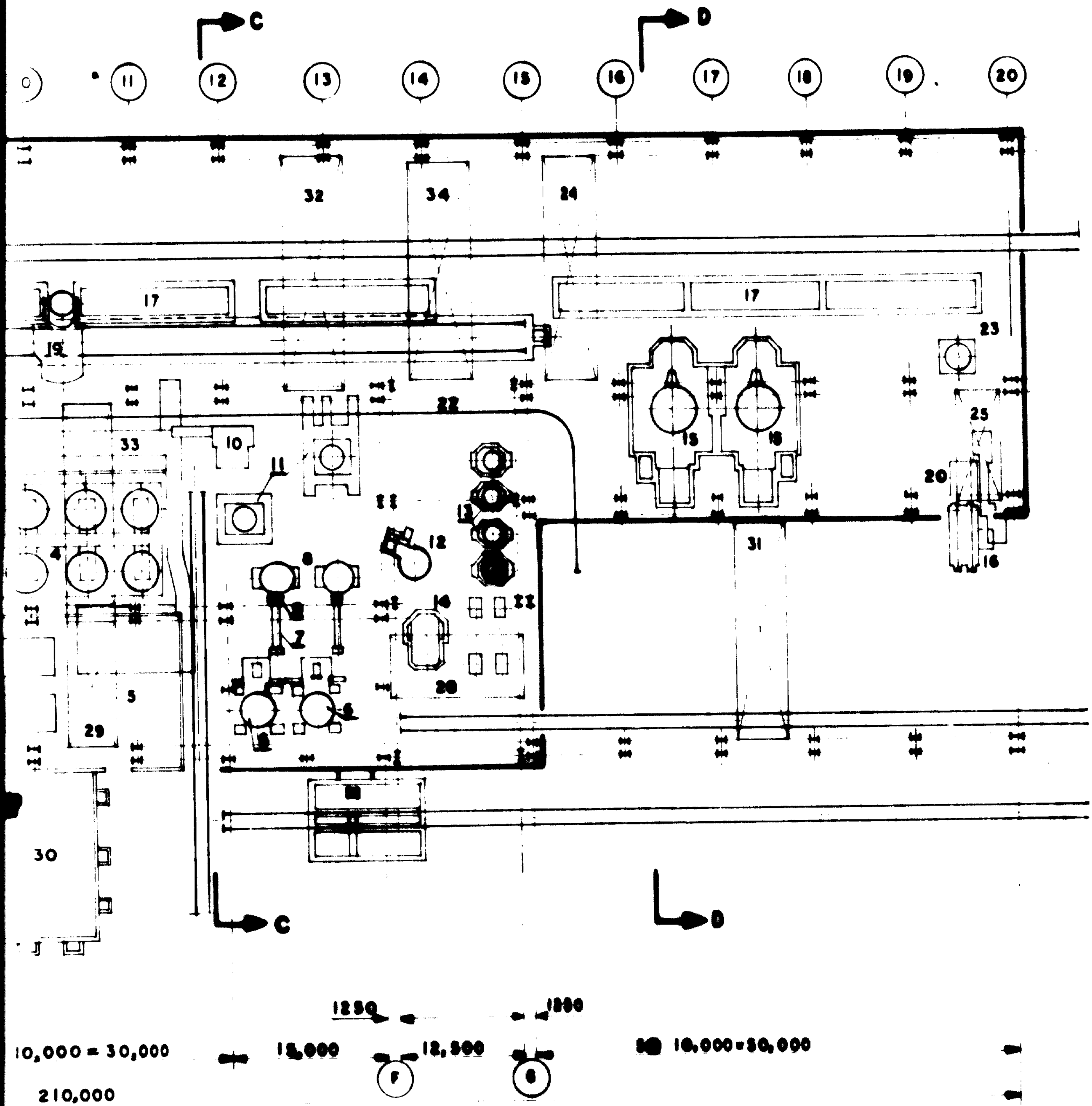
DRAWN	[signature]	15.5.72	No. 519-1-1
APPROVED	[signature]	15.5.72	


A
2X
1X
1
2
3
4
5
6
E
D
C
B
A
1,600
22,250
1,600
10,000
1,000
20,000
60,550
1,400
12,500
1,200
21
26
26
2
2
27
2@ 10,000=20,000
8@ 10,000 = 80,000

SECTION 1


A
B
C
2
3
4
5
6
7
8
9
10
11
12
13
21
35
32
26
17
19
2
2
2
2
3
33
10
11
27
4
8
9
7
18
5
6
29
30
1250
8 @ 10,000 = 80,000
3 @ 10,000 = 30,000
15,000
210,000

SECTION 2


C
D
11
12
13
14
15
16
17
18
19
20
32
34
24
17
17
19
23
22
33
10
11
15
16
25
20
4
13
12
8
14
7
5
29
28
6
31
16
30
1250
1280
10,000 = 30,000
12,000
12,500
10,000=50,000
210,000
F
G

SECTION 3

N

LEGEND

1 500^{T} MIXER
2 $15/17^{T}$ CONVERTER
3 CUPOLA
4 CONVERTER BOTTOM BURNING OVEN
5 BLOWER, POWER, WATER & COMPRESSOR PLANT
6 DOLOMITE SHAFT KILN
7 WORM CONVEYOR
8 PAN MILL
9 CHARGING BIN (HEATED)
10 BRICK PRESS
11 CONVERTER BOTTOM RAMMING MACHINE
12 STOPPER ROD DRIER
13 LADLE DRIER
14 LADLE RELINING PIT
15 12^{T} ELECTRIC FURNACE
16 SCRAP WEIGHING MACHINE
17 CASTING PIT
18 SLAG CAR
19 CASTING CAR
20 SCRAP BASKET CAR
21 MIXER WEIGH SCALE
22 MONORAIL TRACK
23 LADLE DRIER
24 $25/5^{T}$ LADLE CRANE
25 $16/3^{T}$ ELECTRIC FURNACE CHARGING CRANE
26 $50/10^{T}$ LADLE CRANE
27 3^{T} CRANE FOR LIME BUCKET
28 $16/3^{T}$ LADLE CRANE
29 20^{T} OVERHEAD CRANE
30 ELECTRIC SWITCH HOUSE
31 8^{T} MAGNET CRANE
32 10^{T} MOULD HANDLING CRANE
33 $12{\cdot}5^{T}$ OVERHEAD CRANE
34 10^{T} STRIPPER CRANE
35 $25/5^{T}$ LADLE CRANE

SECTION 4

10 0 10 20 30 40

SCALE : METRES

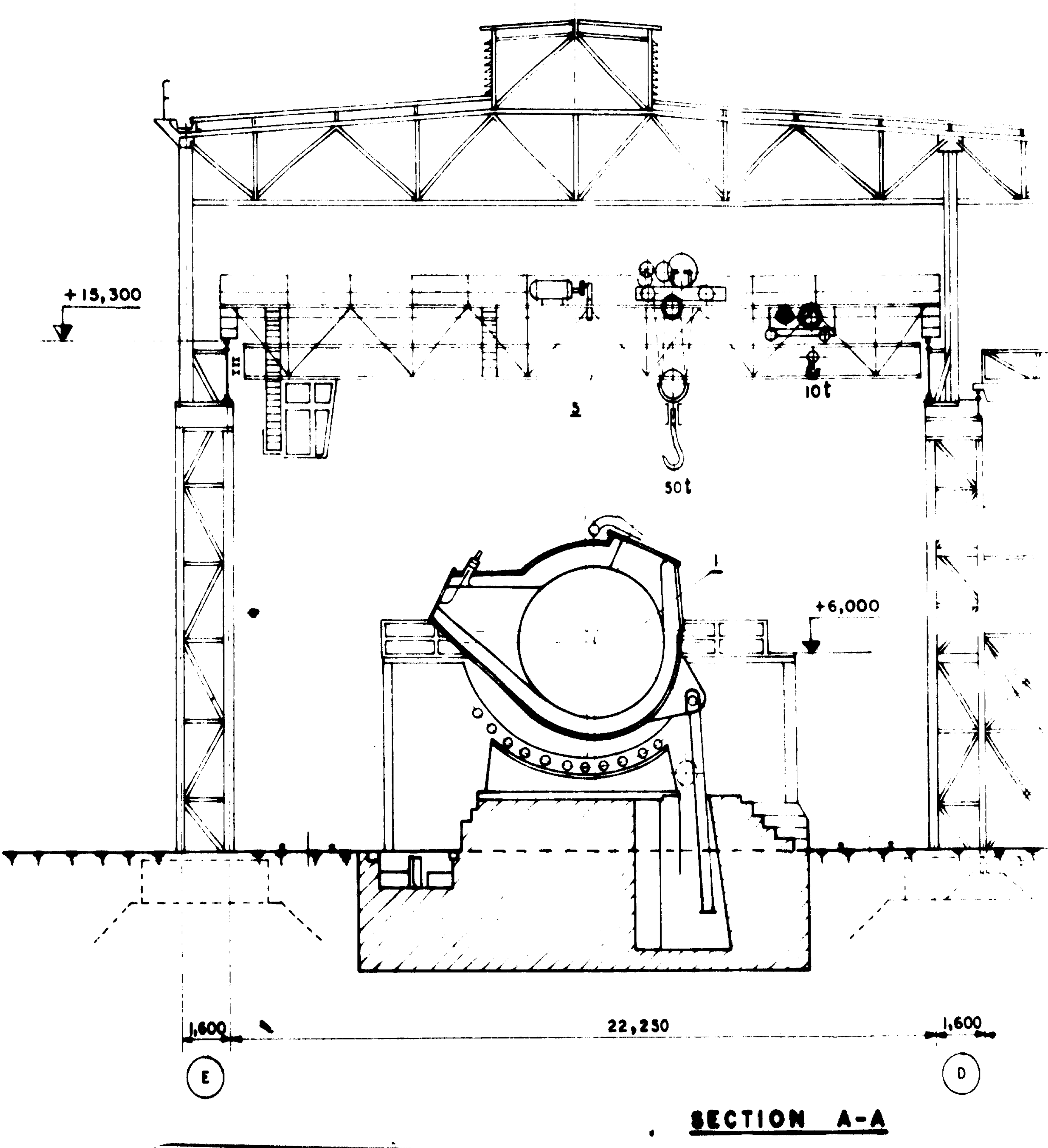
DASTUR ENGINEERING INTERNATIONAL GmbH
CONSULTING ENGINEERS, DÜSSELDORF

FOR: UNITED NATIONS
INDUSTRIAL DEVELOPMENT ORGANIZATION

HELWAN IRON & STEEL PLANT
EXISTING STEELMELT SHOP — LAYOUT

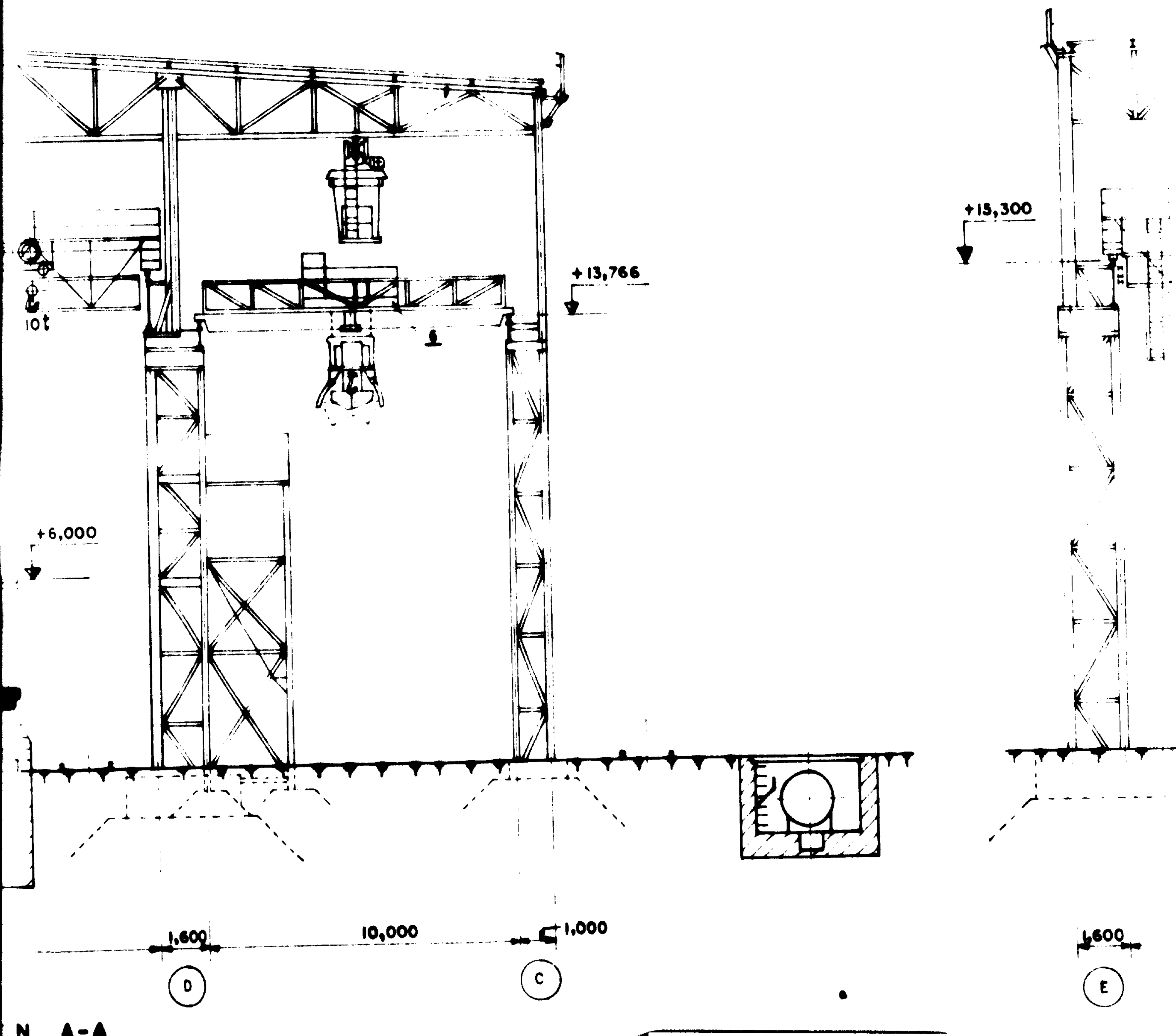
DRAWN	[signature]	3.5.72	No. 519-2-1
APPROVED	Akhtari	5.5.72	

NOTE:
FOR SECTIONS, REFER DWG. NOS. 519-2-2, 519-2-3 AND 519-2-4.

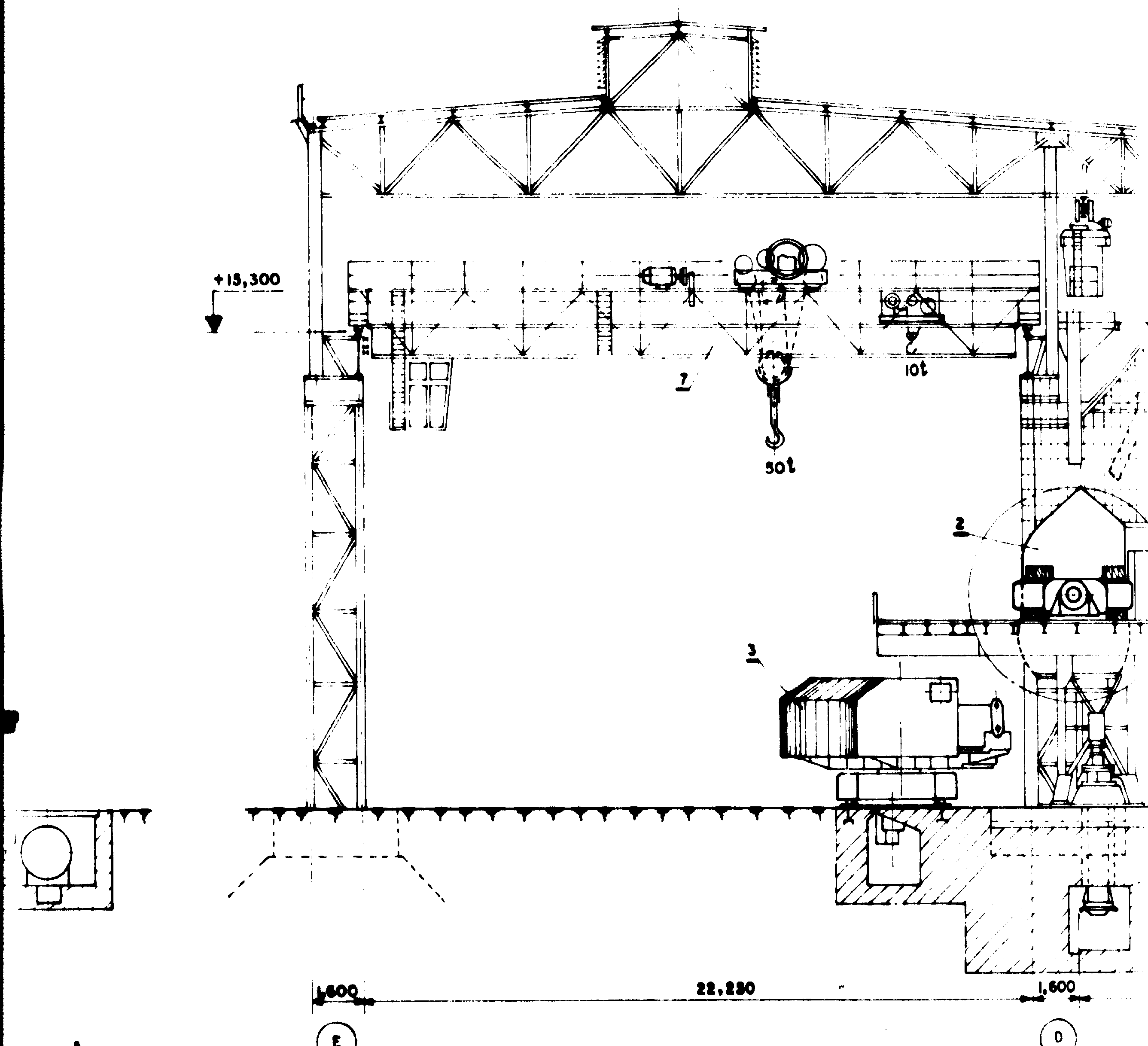


SECTION A-A

SECTION 1

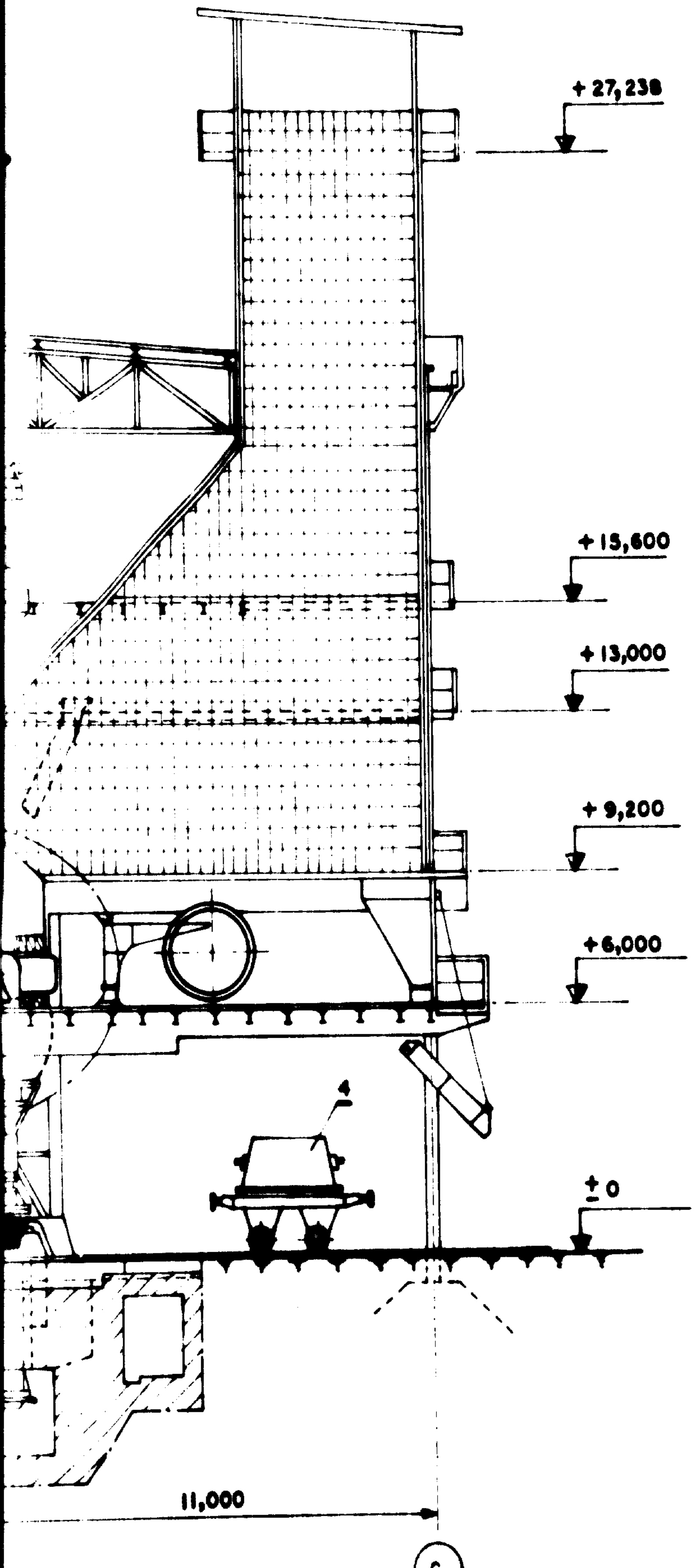


SECTION 2



SECTION B-B

SECTION 3



LEGEND

1 500^T MIXER
2 15/17^T THOMAS CONVERTER
3 CASTING CAR
4 SLAG CAR
5 50/10^T LADLE CRANE
6 3^T CRANE FOR LIME BUCKET
7 50/10^T LADLE CRANE

SECTION 4

5 0 5 10
SCALE : METRES

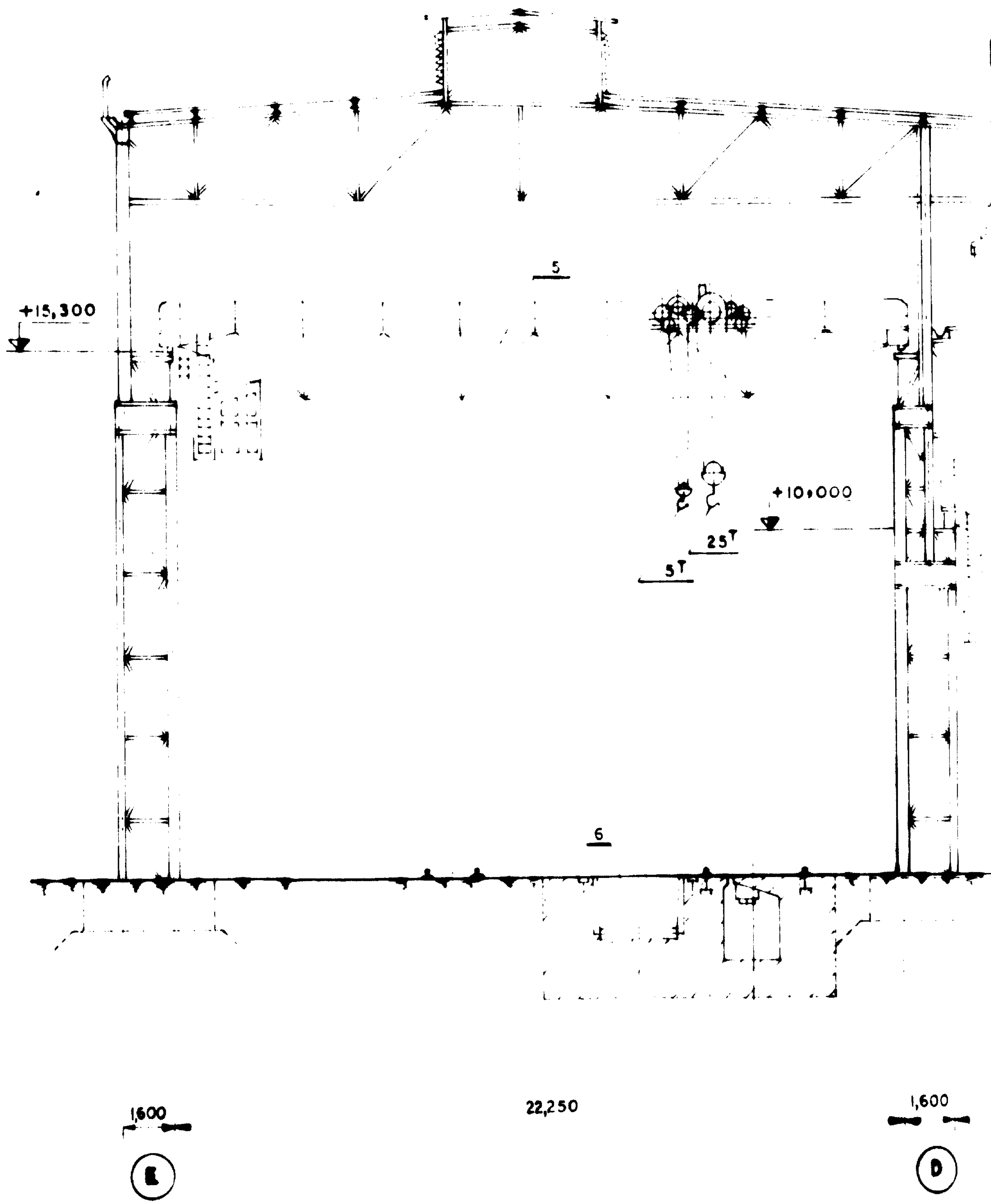
DASTUR ENGINEERING INTERNATIONAL GmbH
CONSULTING ENGINEERS, DÜSSELDORF

FOR: UNITED NATIONS
INDUSTRIAL DEVELOPMENT ORGANIZATION

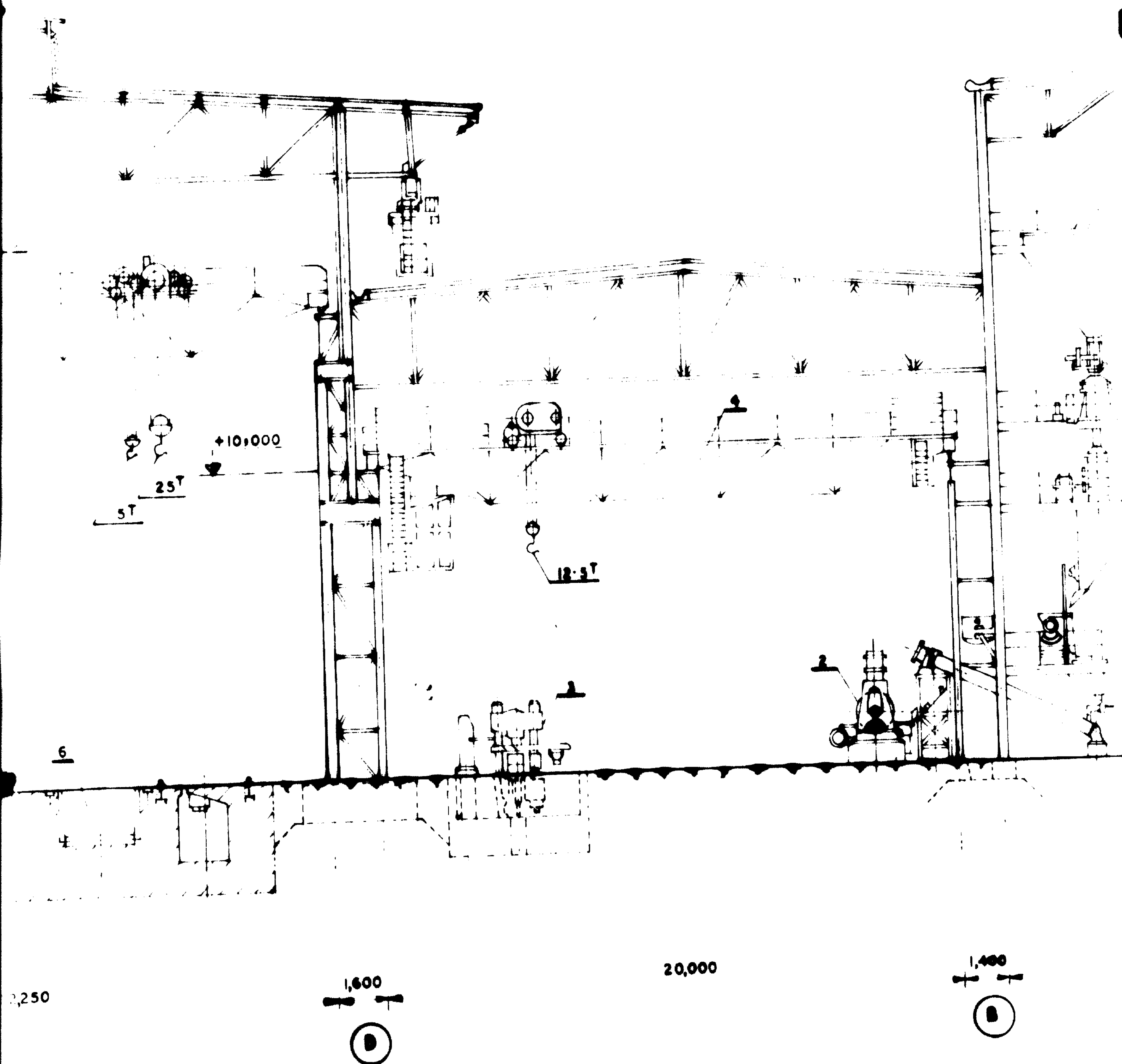
HELWAN IRON & STEEL PLANT
EXISTING STEELMELT SHOP-SECTION A-A AND B-B

DRAWN	[illegible]	8.5.72	No. 519-2-2
APPROVED	[illegible]	11.5.72	

NOTE: FOR PLAN, REFER DRAWING No. 519-2-1

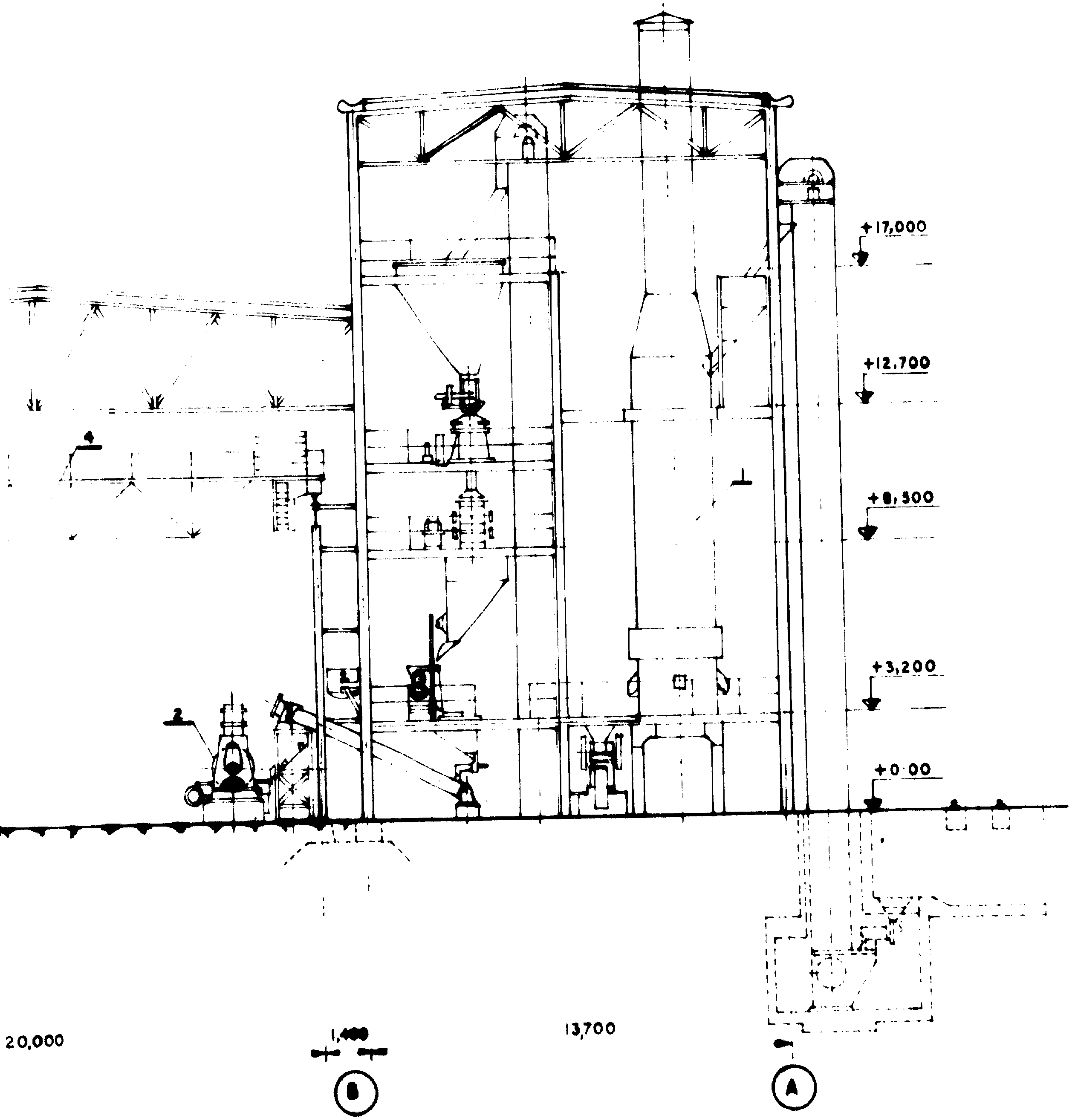


SECTION 1



SECTION C-C

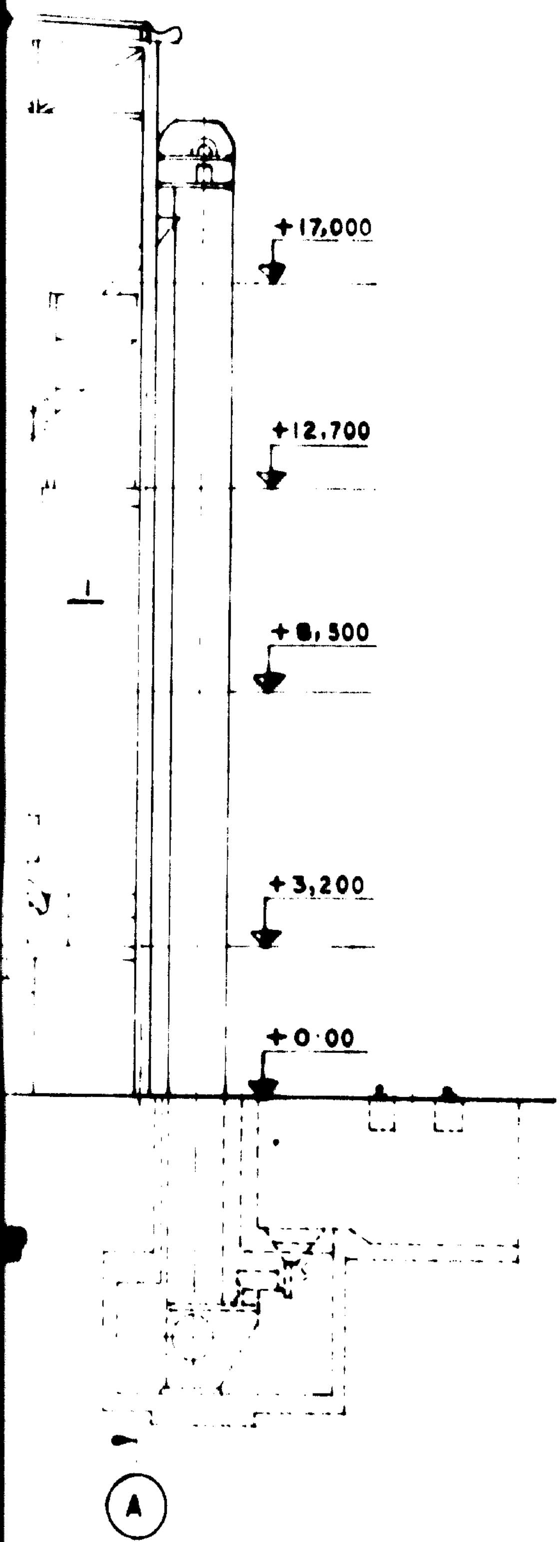
SECTION 2



TION C-C

SECTION 3

NOTE. FOR PLAN, REFER DWG No 519-2-1



LEGEND

1 DOLOMITE SHAFT KILN

2 PAN MILL

3 CONVERTER BOTTOM RAMMING MACHINE

4 12·5^T OVERHEAD CRANE

5 25/5^T LADLE CRANE

6 CASTING PIT

SECTION 4

5 0 5 10

SCALE : METRES

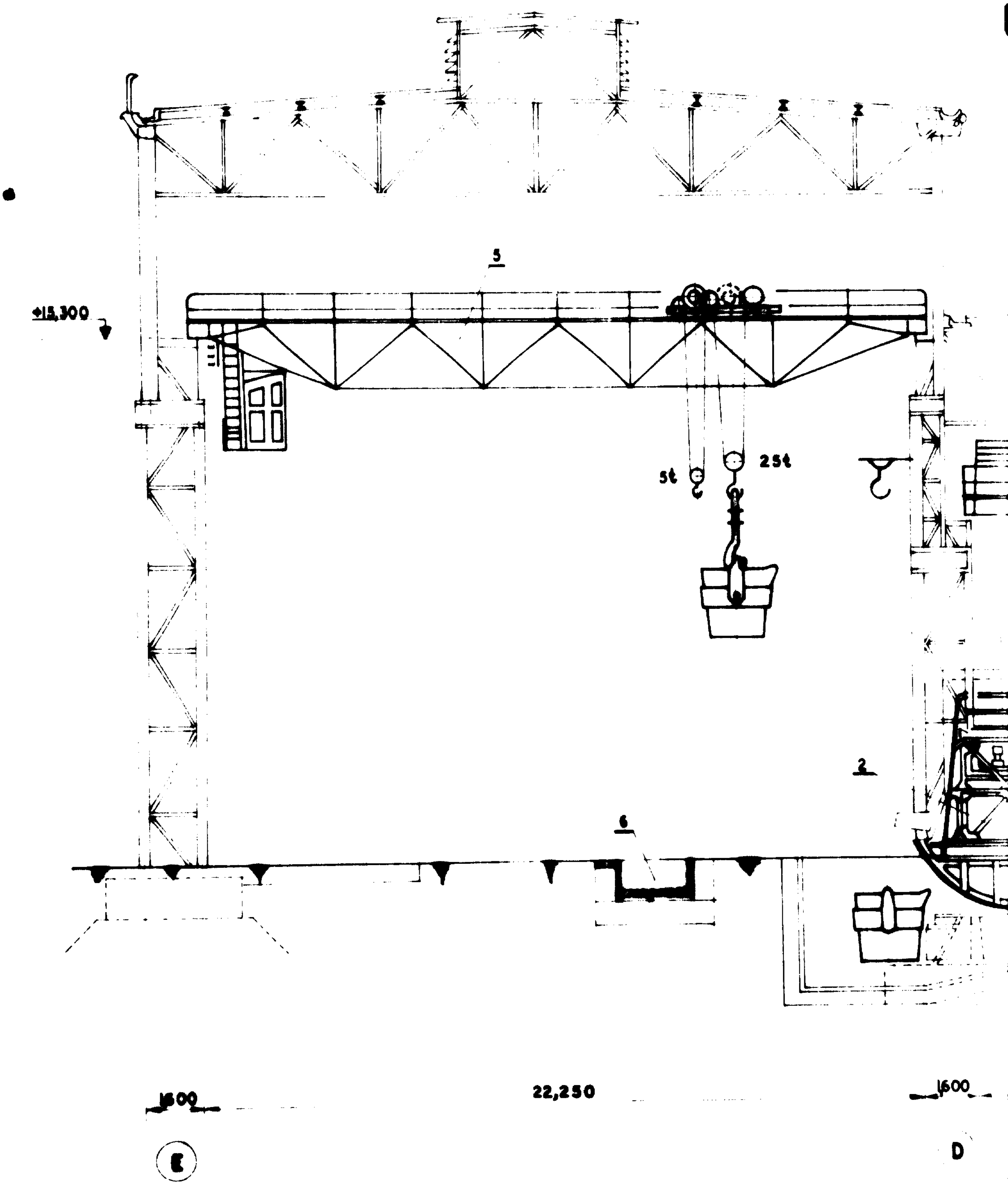
NOTE
FOR PLAN, REFER DWG No 519-2-1

DASTUR ENGINEERING INTERNATIONAL GmbH
CONSULTING ENGINEERS, DÜSSELDORF

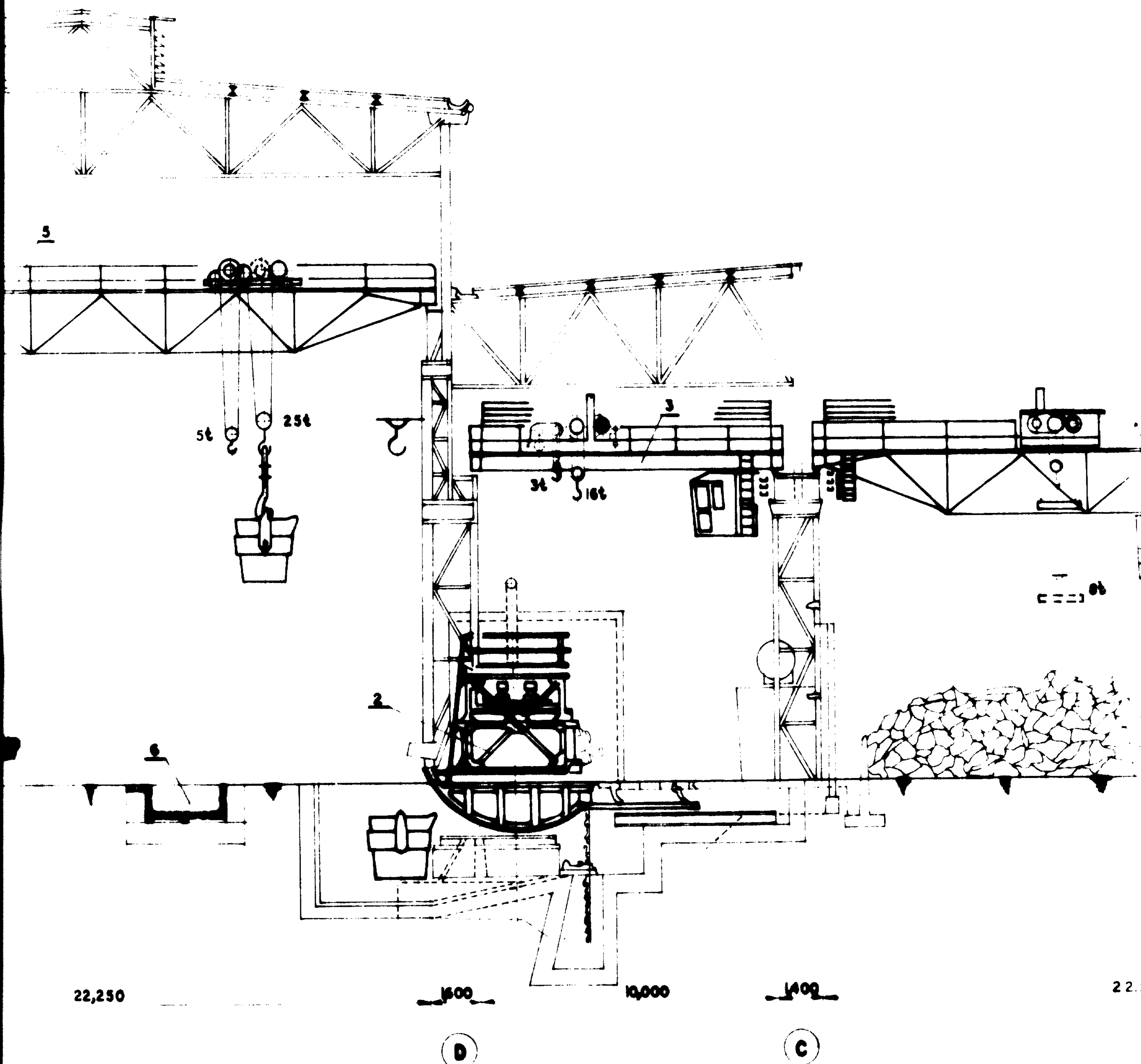
FOR:
UNITED NATIONS
INDUSTRIAL DEVELOPMENT ORGANIZATION

HELWAN IRON & STEEL PLANT
EXISTING STEELMELT SHOP - SECTION C-C

DRAWN	[signature]	11.5.72	No. 519-2-3
APPROVED	[signature]	15.5.72	



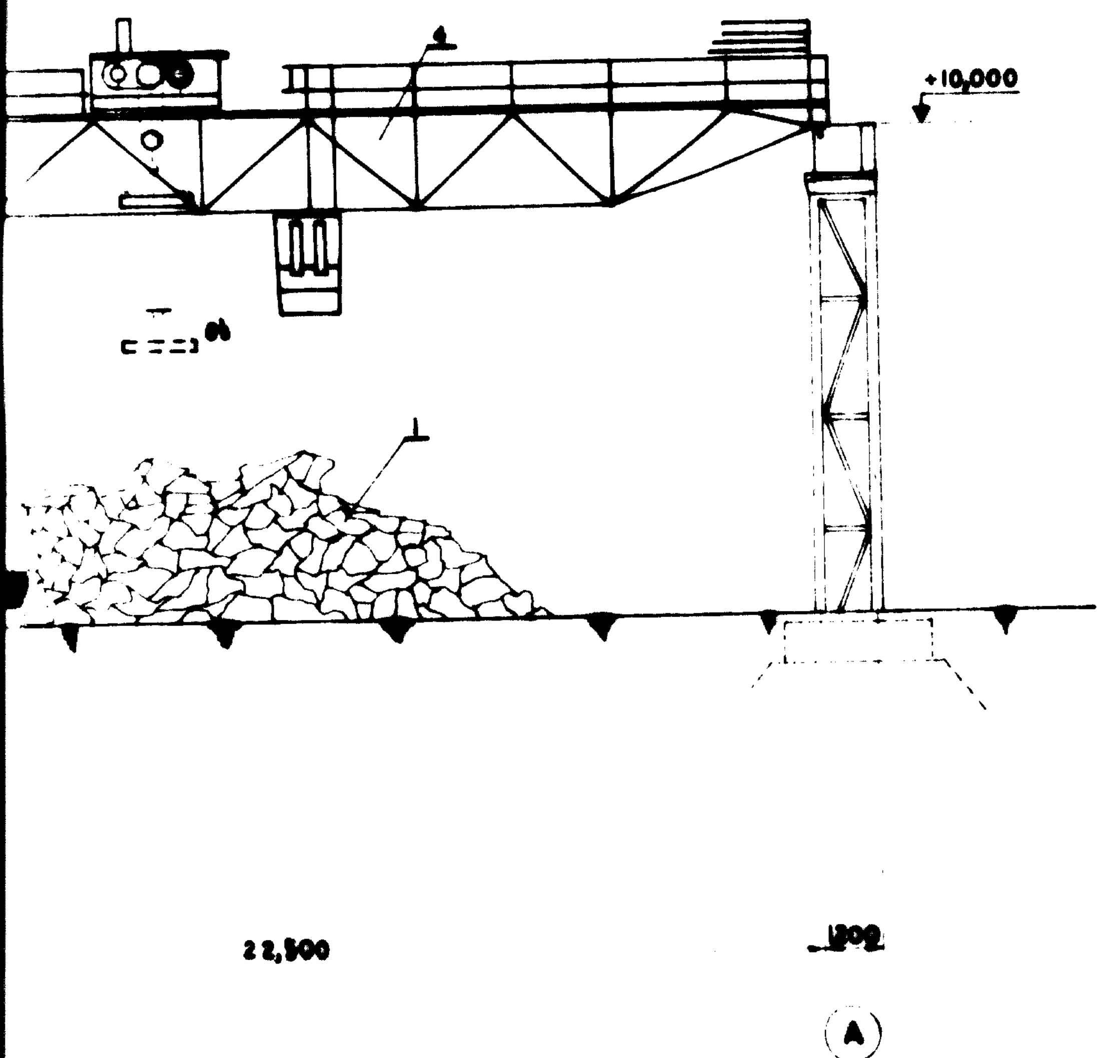
SECTION 1



SECTION D-D

SECTION 2

SECTION 3



NOTE: FOR PLAN, REFER DRG No. 519-2-1

LEGEN[D]

1	SCRAP ST[O]
2	12T ELECTR[I]
3	16/3 T ELEC[T]
4	8 T MAGNE[T]
5	25/5 T LA[DLE]
6	CASTING P[IT]

5 0

SCA[LE]

DASTUR ENGINEER[ING]

CONSULTING

FOR: UNI[TED]

INDUSTRIAL DEV[ELOPMENT]

HELWAN IR[ON]

EXISTING STE[EL]

DRAWN	
APPROVED	

LEGEND

1 SCRAP STORAGE
2 12^{T} ELECTRIC FURNACE
3 16/3 T ELECTRIC FURNACE CHARGING CRANE
4 8 T MAGNET CRANE
5 25/5 T LADLE CRANE
6 CASTING PIT

SECTION 4

5 0 5 10
SCALE : METRES

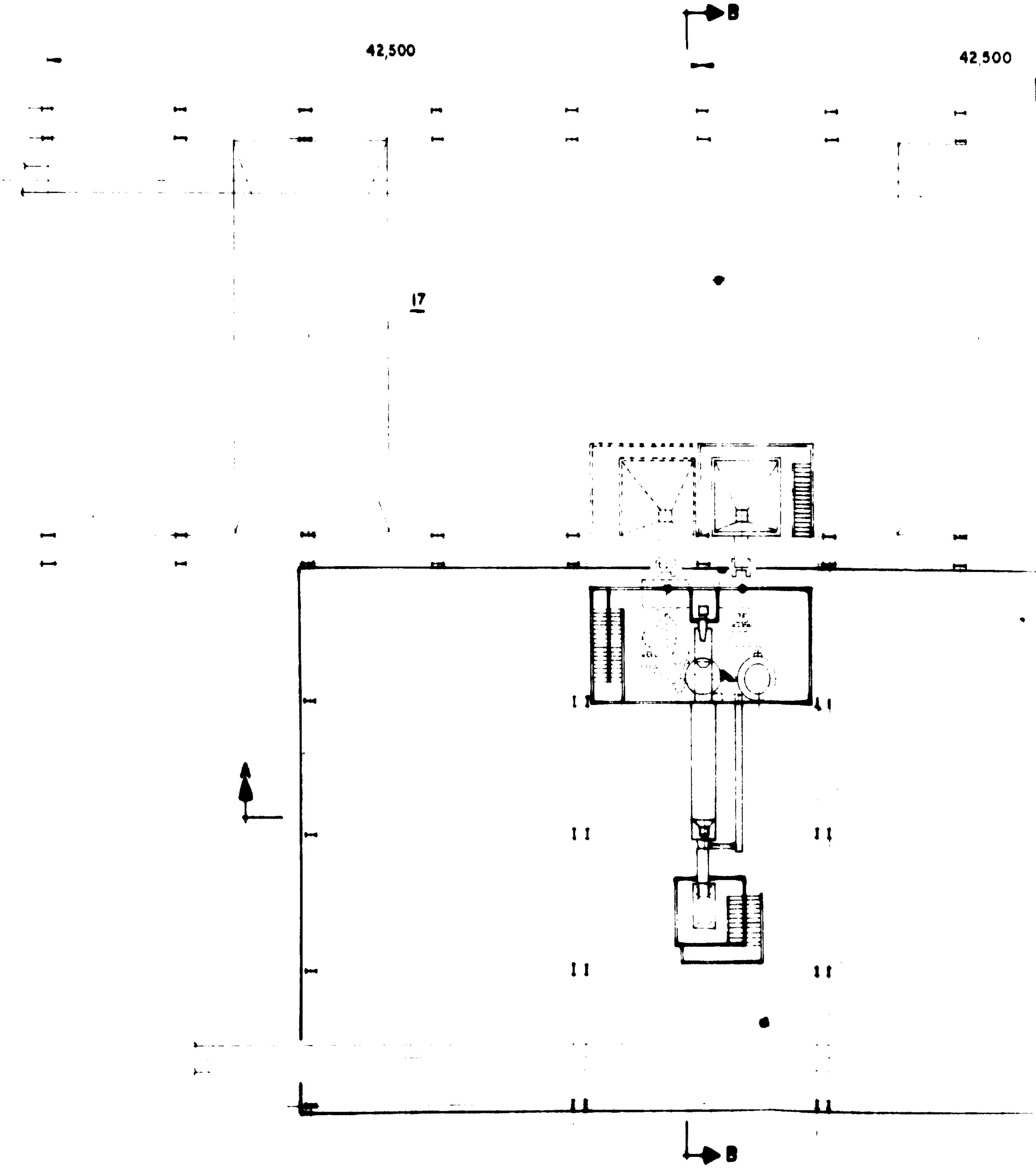
DASTUR ENGINEERING INTERNATIONAL GmbH
CONSULTING ENGINEERS, DÜSSELDORF

FOR: UNITED NATIONS
INDUSTRIAL DEVELOPMENT ORGANIZATION

HELWAN IRON & STEEL PLANT
EXISTING STEELMELT SHOP — SECTION D-D

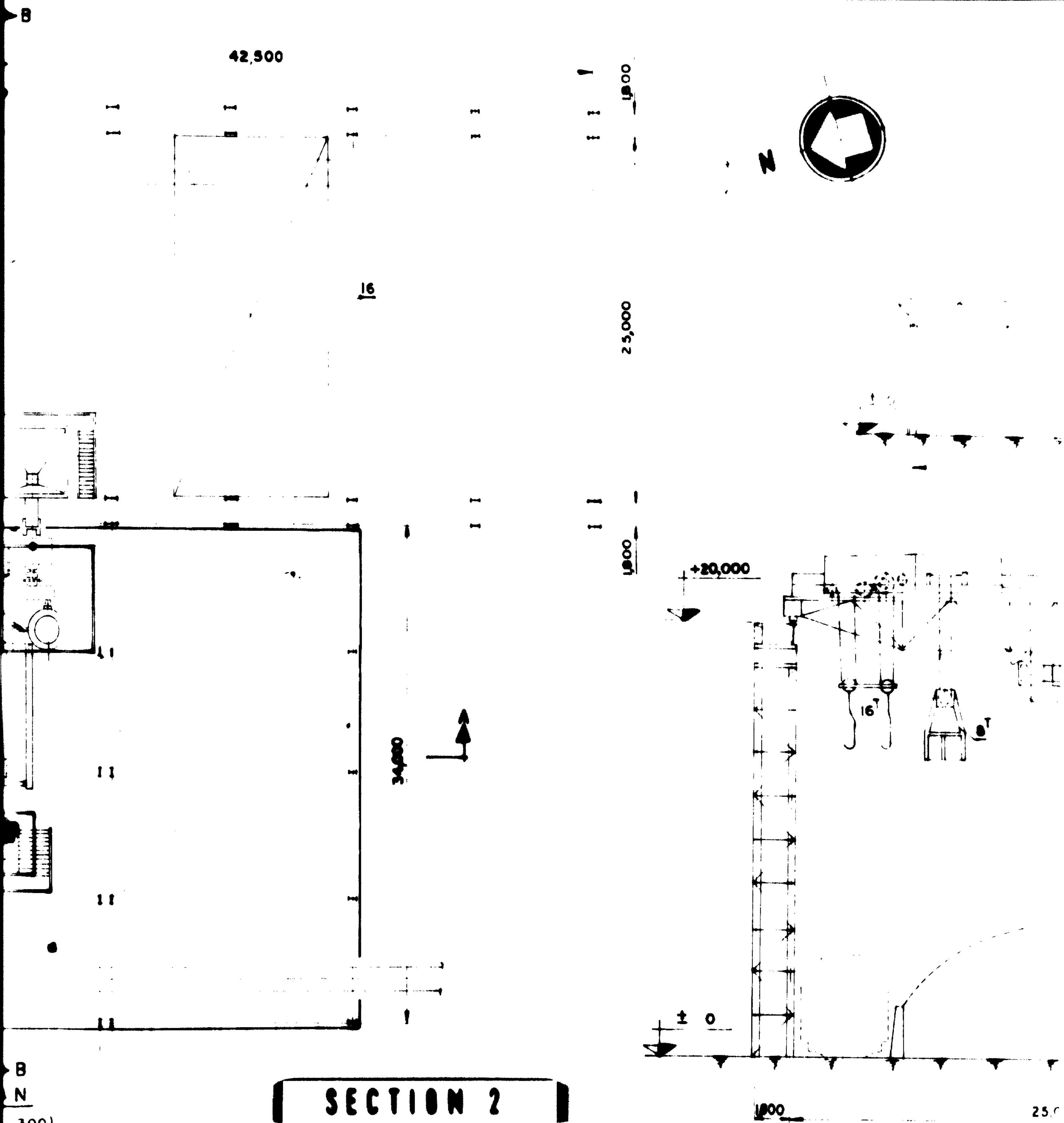
DRAWN	[illegible]	15.5.72	No. 519-2-4
APPROVED	Aklahiri	18.5.72	

G No. 519-2-1



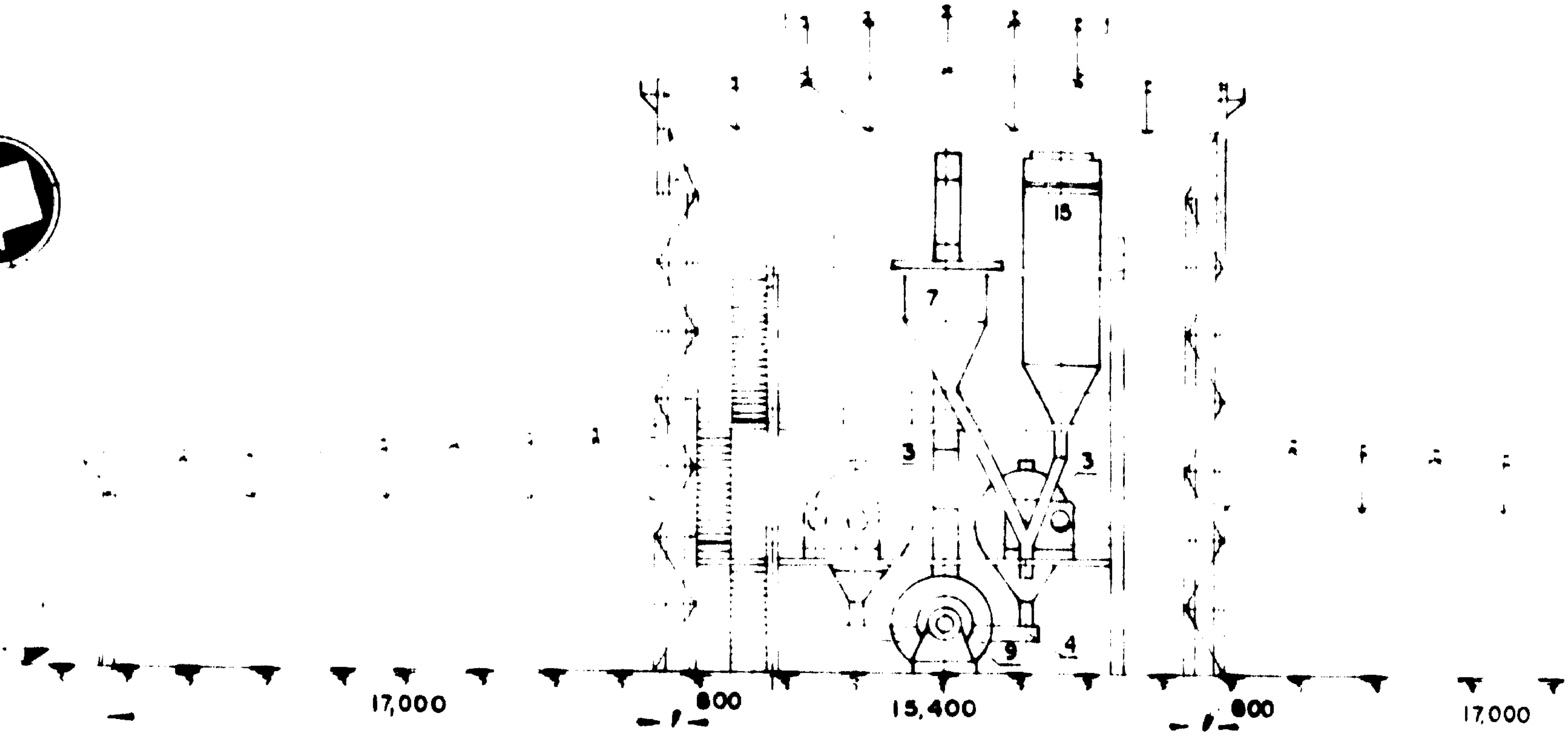
PLAN
(SCALE 1:300)

SECTION 1

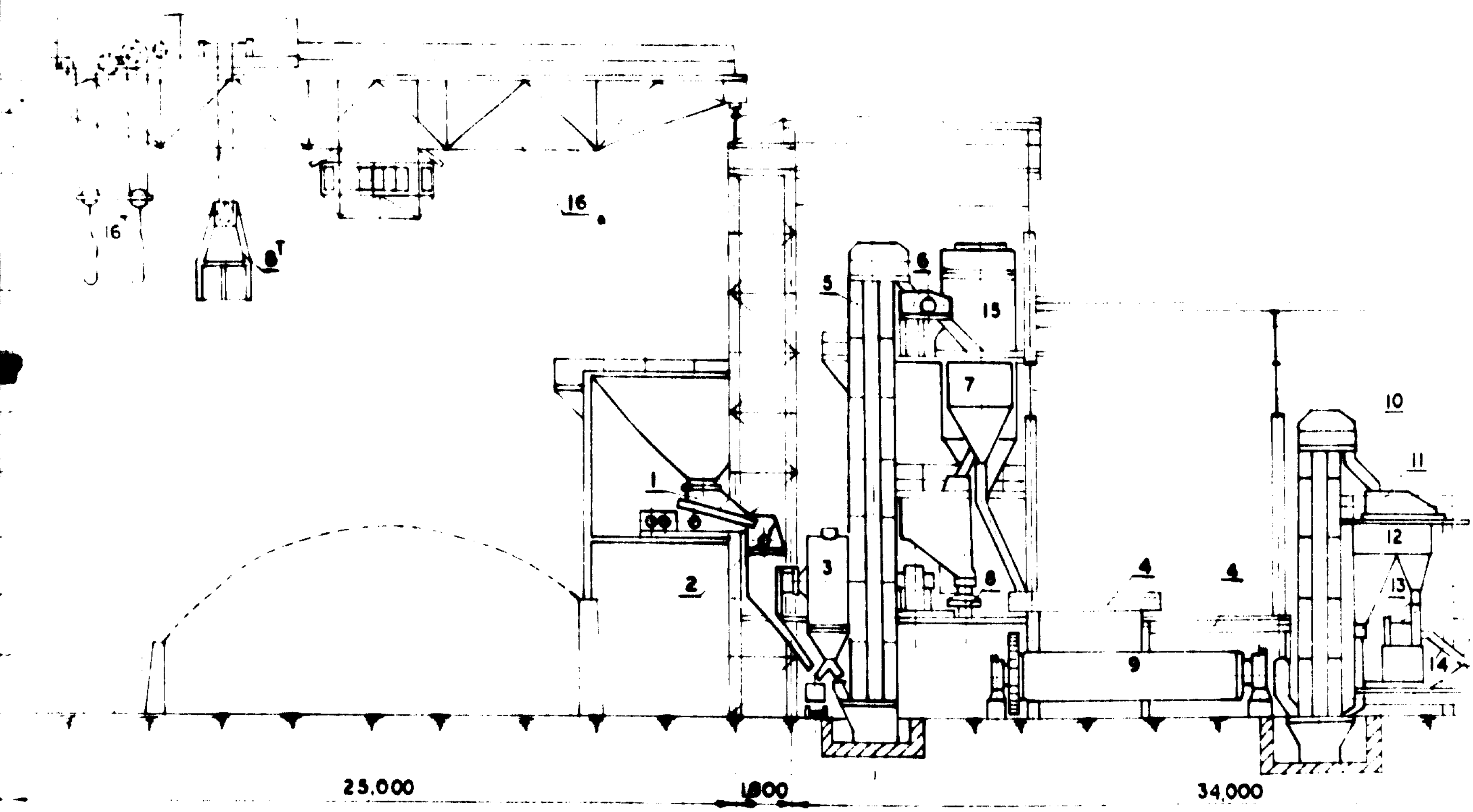


B
42,500
1,800
N
16
25,000
1,800
+20,000
16T
8T
34,000
± 0
B
N
300)
1,800
25,0

SECTION 2

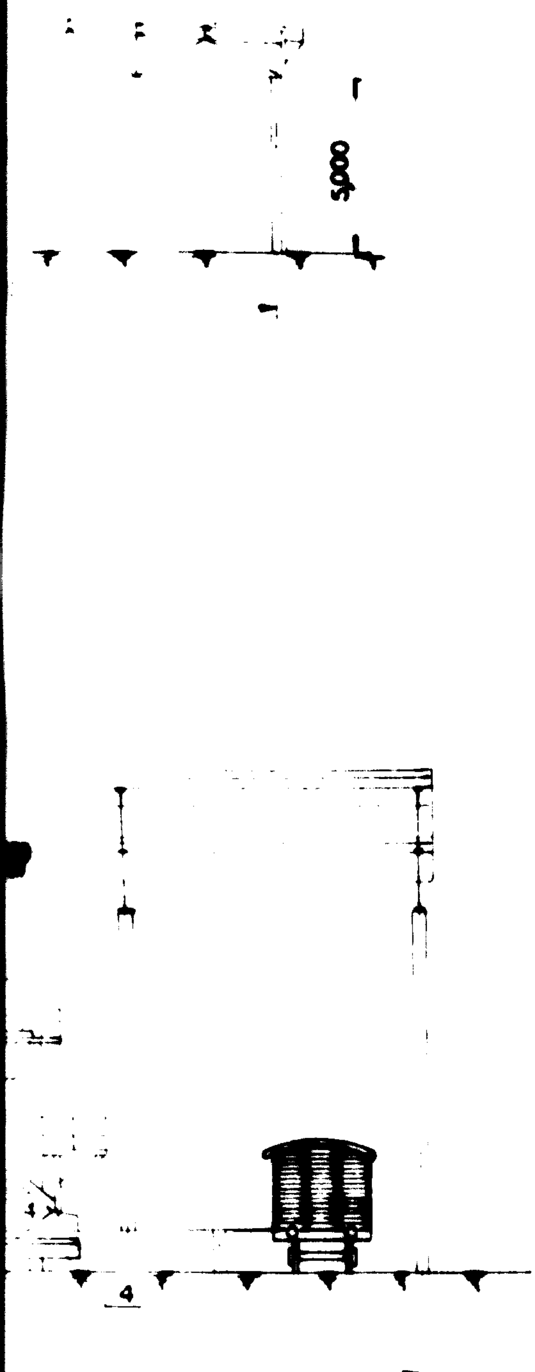


SECTION A-A
(SCALE 1:200)



SECTION B-B
(SCALE 1:200)

SECTION 3



LEGEND

1 BIN GATES
2 ELECTRO-MAGNETIC DRUM
3 BALL GRINDING MILLS
4 SCREW CONVEYOR
5 BUCKET ELEVATOR
6 ELECTRO-MAGNETIC DRUM
7 PNEUMATIC SEPARATOR
8 ROTARY FEEDER
9 TWO CHAMBER TUBE MILL
10 BUCKET ELEVATOR
11 VIBRATORY SCREEN
12 INTERMEDIATE BIN
13 VALVE TYPE BAGGING MACHINE
14 COLLECTING FUNNEL AND PACKING
15 DUST CATCHER
16 10^T MAGNET CRANE
17 $16/8^T$ OVERHEAD CRANE

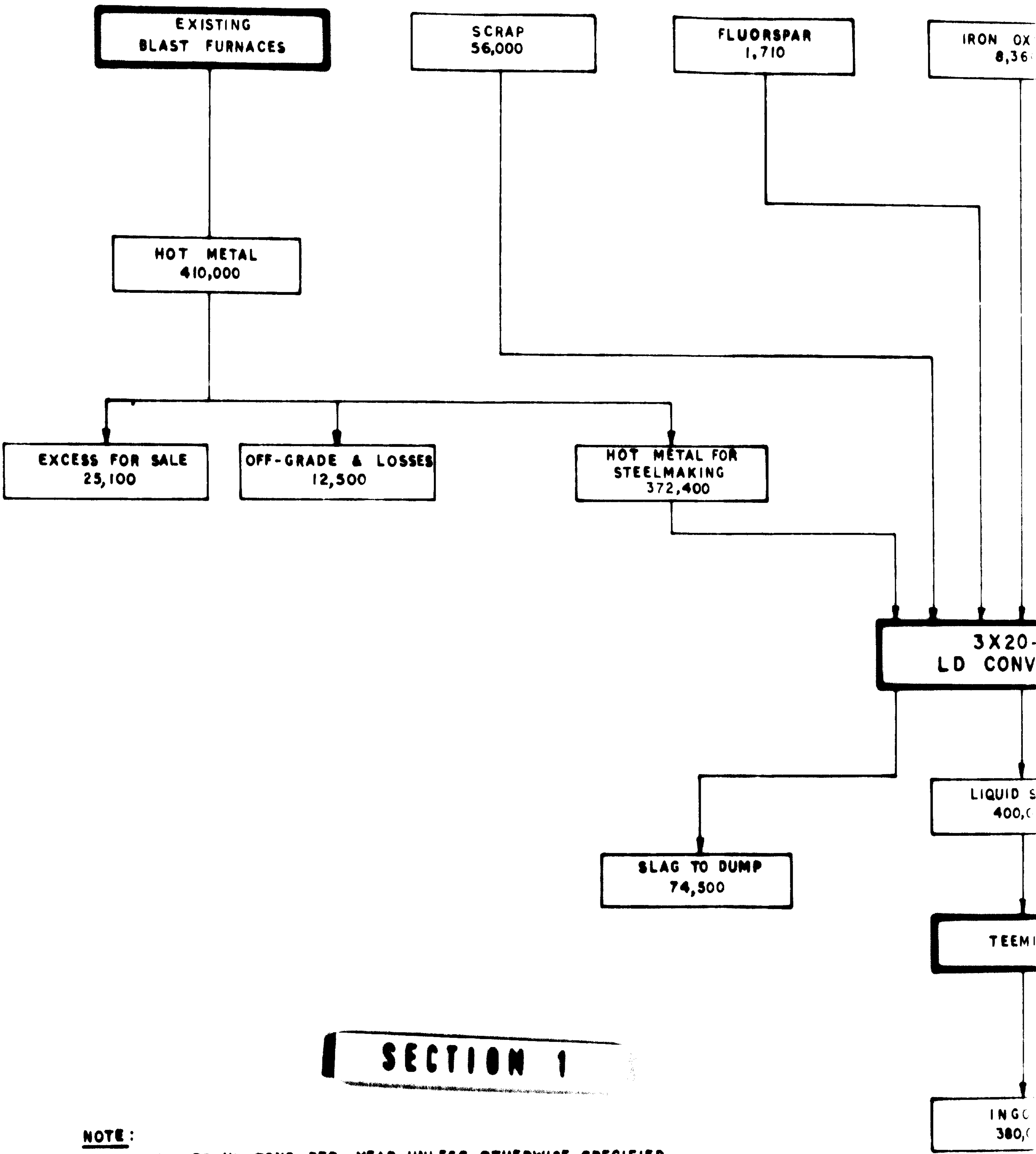
SECTION 4

DASTUR ENGINEERING INTERNATIONAL GmbH
CONSULTING ENGINEERS, DÜSSELDORF

FOR: UNITED NATIONS
INDUSTRIAL DEVELOPMENT ORGANIZATION

HELWAN IRON & STEEL PLANT
EXISTING SLAG YARD

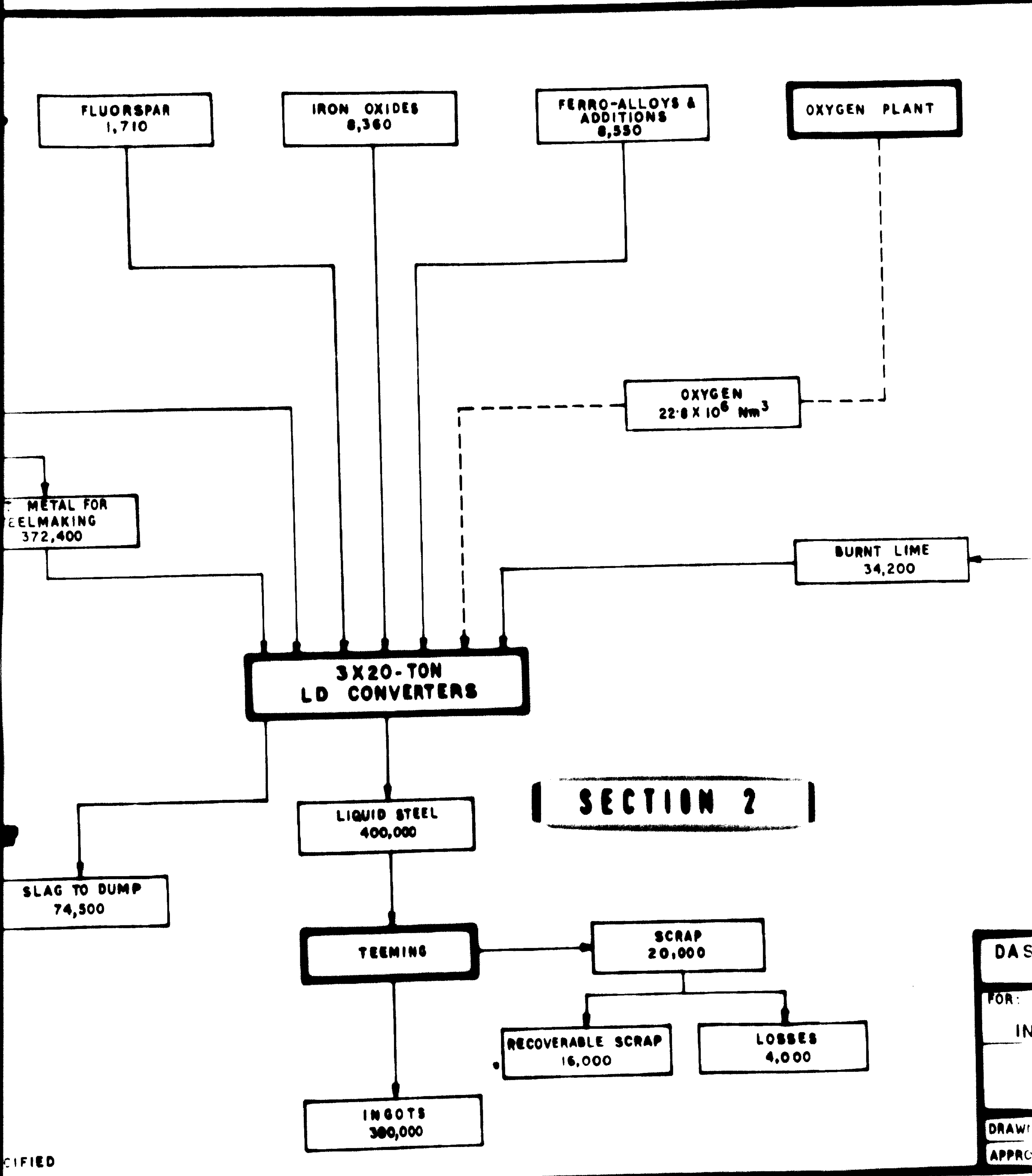
DRAWN	[illegible]	4.5.72	No. 519-2-5
APPROVED	[illegible]	8.5.72	

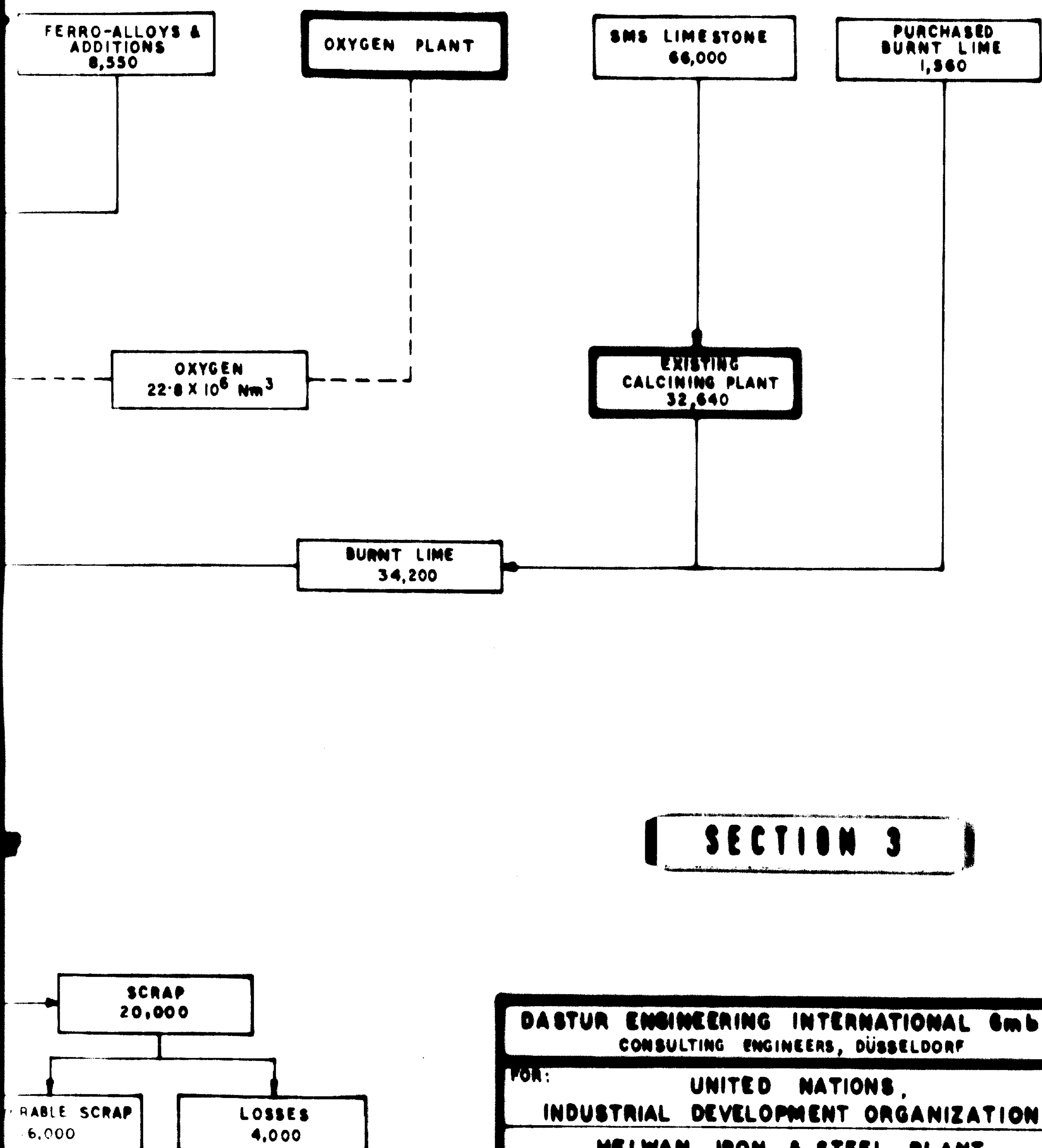


SECTION 1

NOTE:

QUANTITIES IN TONS PER YEAR UNLESS OTHERWISE SPECIFIED


FLUORSPAR
1,710
IRON OXIDES
8,360
FERRO-ALLOYS & ADDITIONS
8,550
OXYGEN PLANT
OXYGEN
22·8 X 10^6 Nm^3
METAL FOR
372,400
BURNT LIME
34,200
3X20-TON
LD CONVERTERS
SECTION 2
LIQUID STEEL
400,000
SLAG TO DUMP
74,500
TEEMING
SCRAP
20,000
RECOVERABLE SCRAP
16,000
LOSSES
4,000
INGOTS
380,000



DASTUR ENGINEERING INTERNATIONAL GmbH
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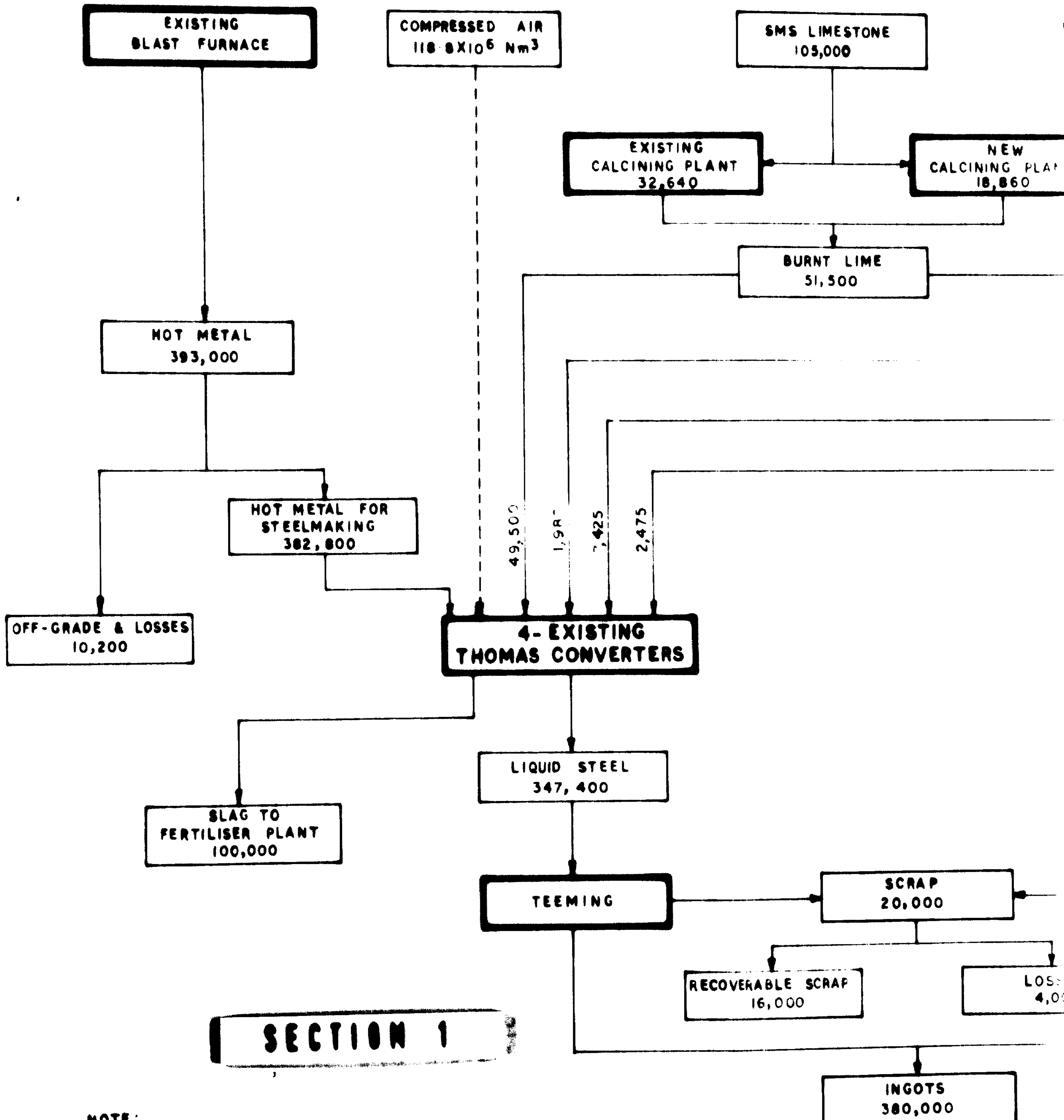
FOR: UNITED NATIONS,
INDUSTRIAL DEVELOPMENT ORGANIZATION

HELWAN IRON & STEEL PLANT

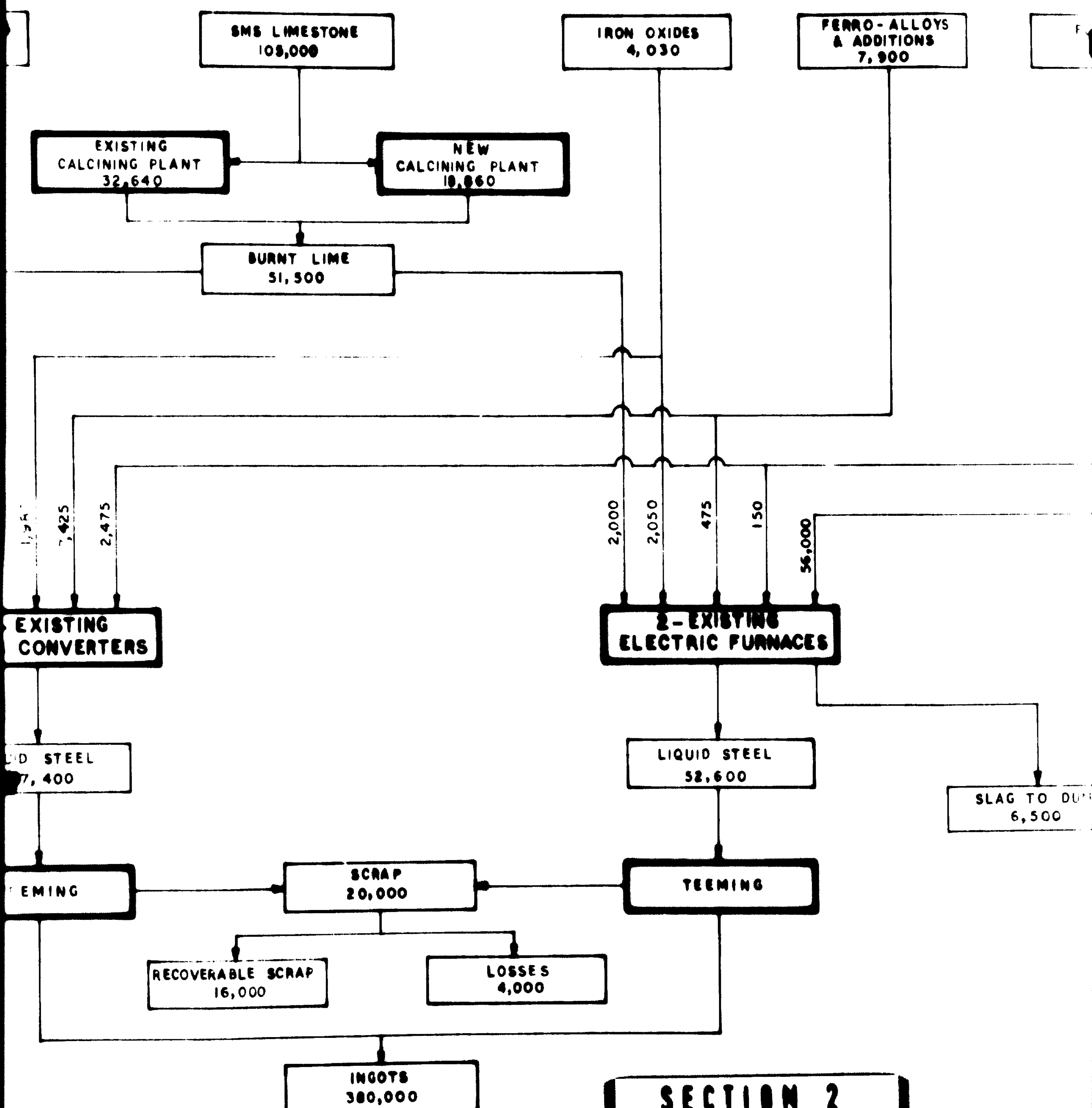
FLOW-SHEET — ALT. I MODIFICATION

DRAWN	[signature]	19.5.72	No. 519-3-1
APPROVED	[signature]	22.5.72	



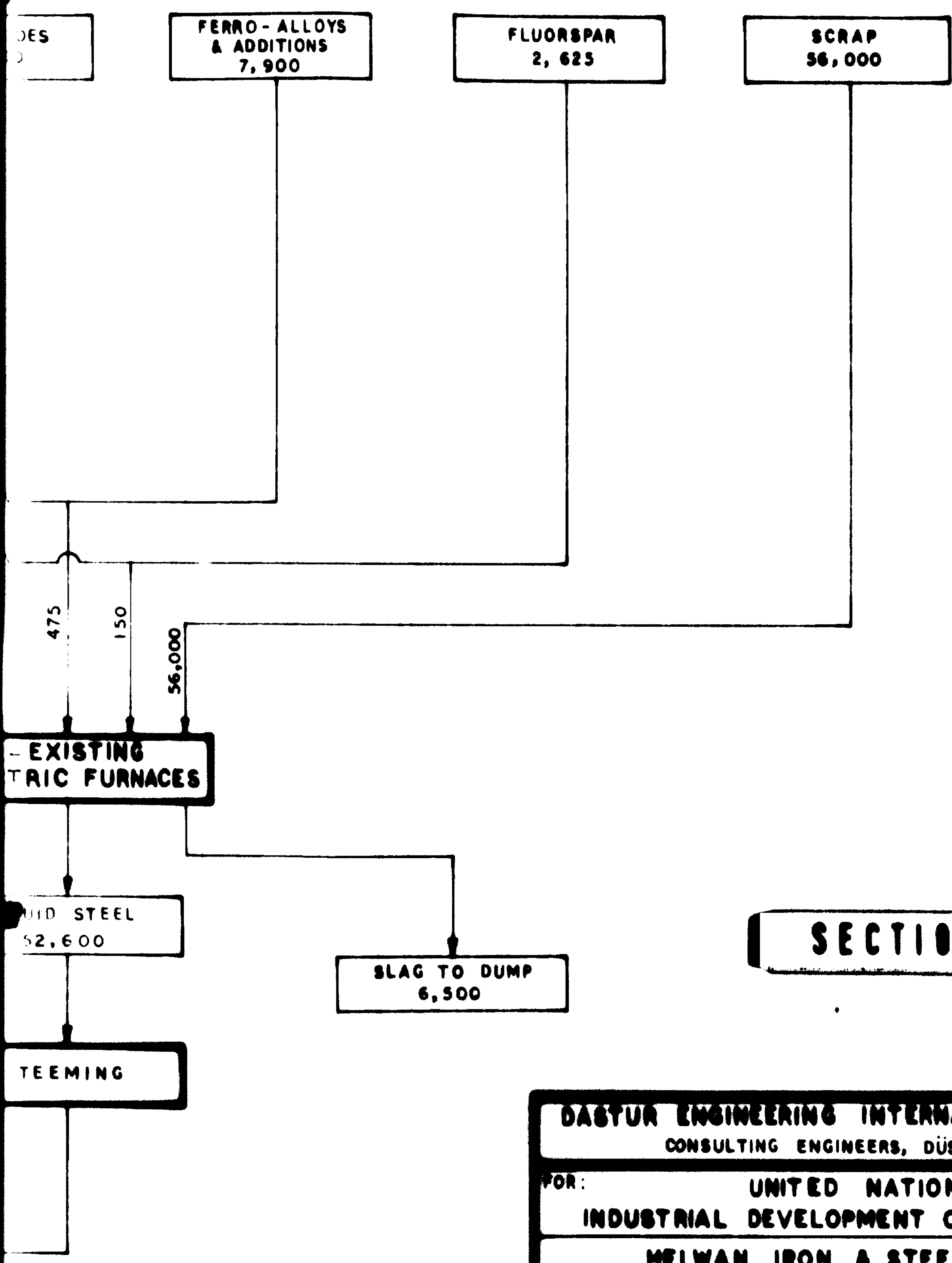
SECTION 1

NOTE:
QUANTITIES IN TONS PER YEAR UNLESS OTHERWISE SPECIFIED



WISE SPECIFIED

SECTION 2



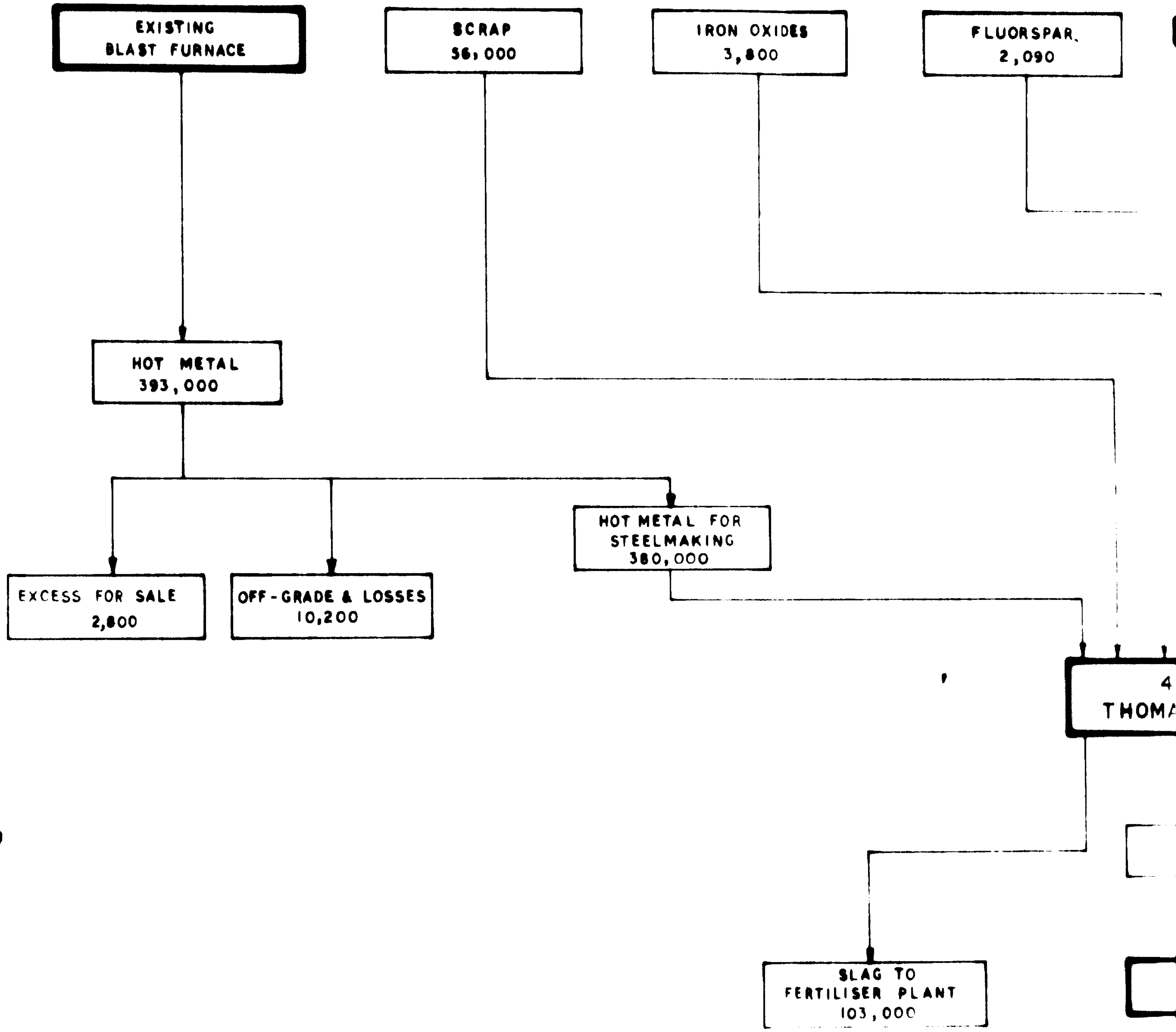
SECTION 3

DASTUR ENGINEERING INTERNATIONAL GmbH
CONSULTING ENGINEERS, DÜSSELDORF

FOR: **UNITED NATIONS INDUSTRIAL DEVELOPMENT ORGANIZATION**

HELWAN IRON & STEEL PLANT
FLOW-SHEET — ALT. 2 MODIFICATION

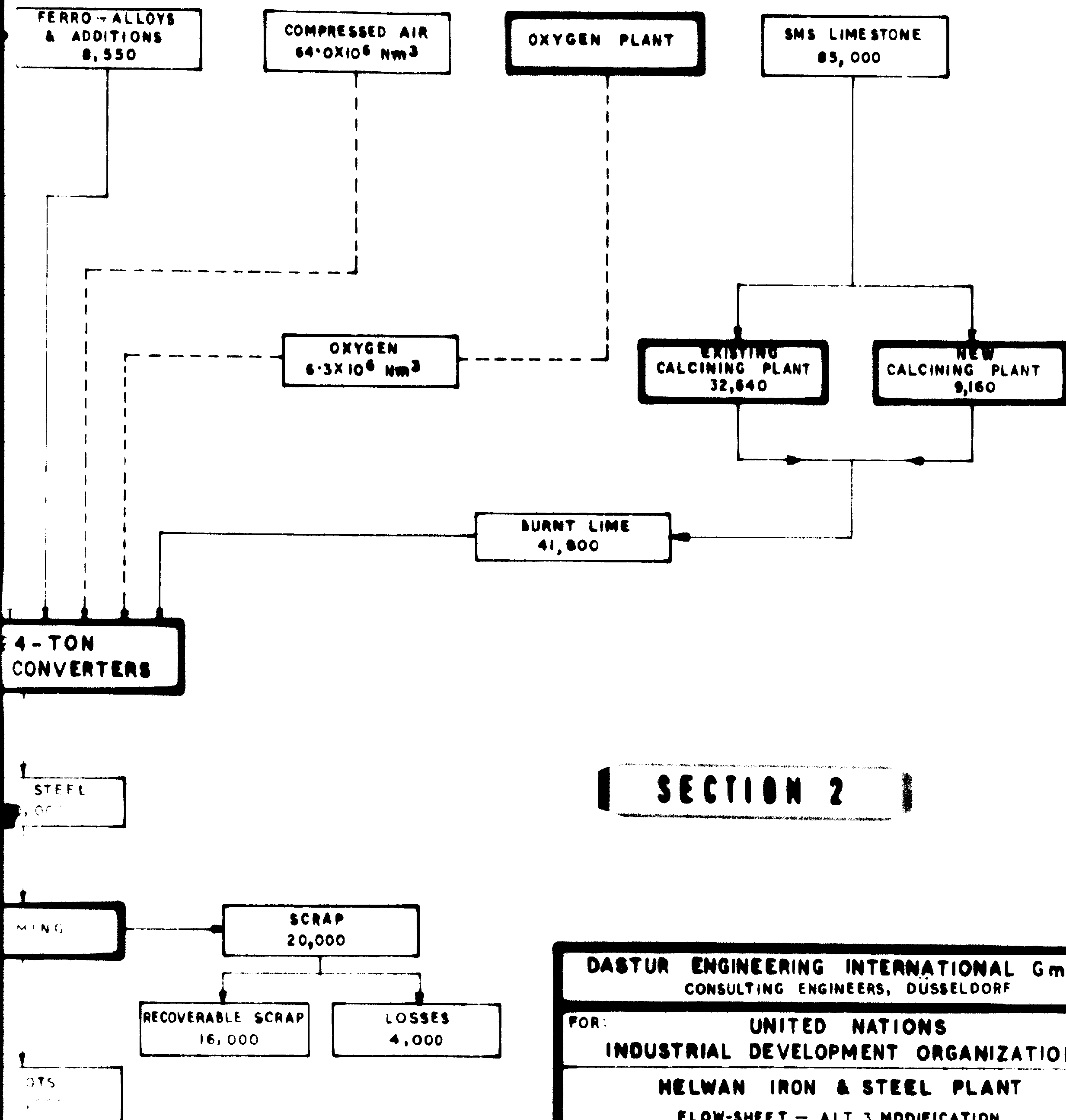
DRAWN	[signature]	24.5.72	No. 519-3-2
APPROVED	[signature]	26.5.72	



SECTION 1

NOTE:

QUANTITIES IN TONS PER YEAR UNLESS OTHERWISE SPECIFIED



SECTION 2

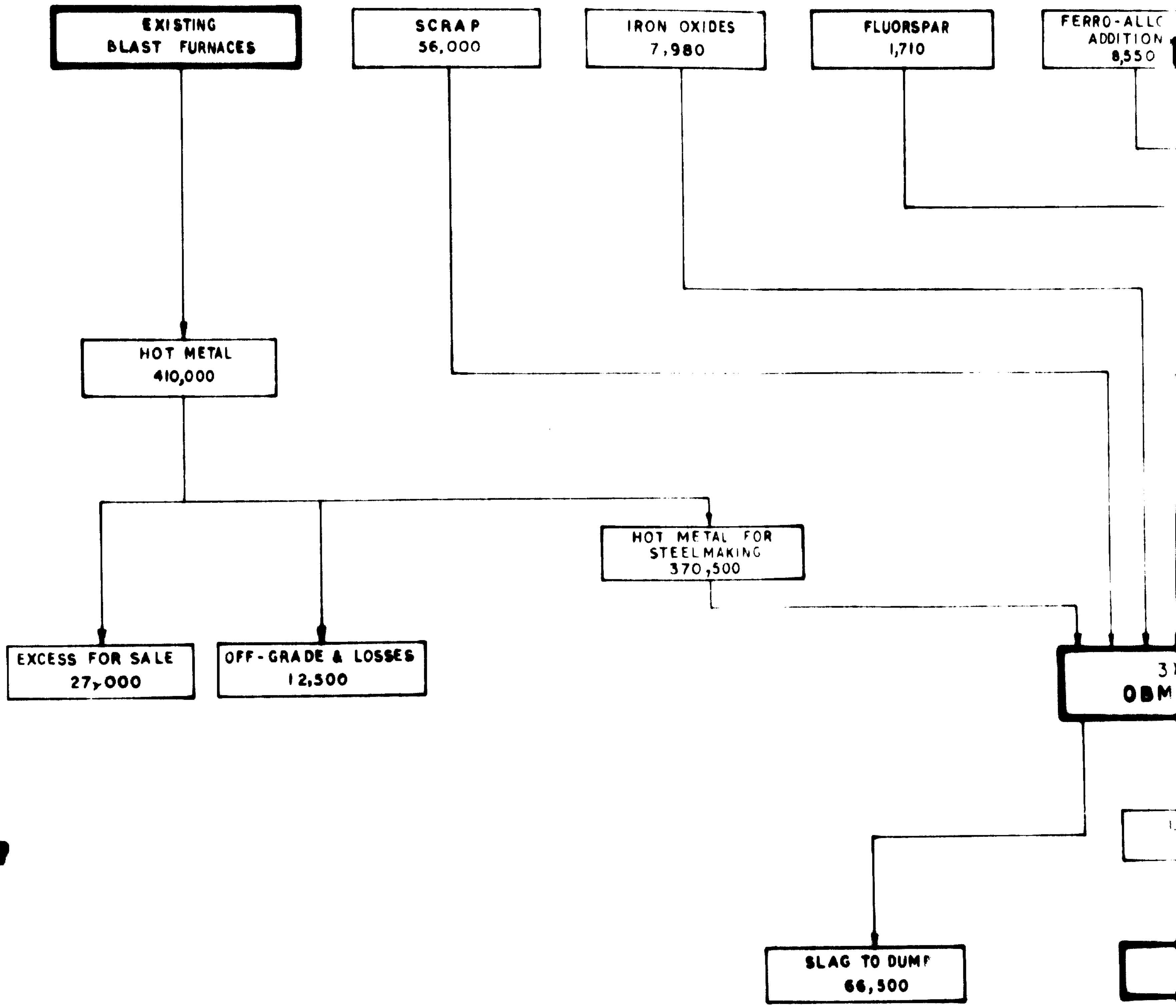
DASTUR ENGINEERING INTERNATIONAL GmbH
CONSULTING ENGINEERS, DÜSSELDORF

FOR: UNITED NATIONS
INDUSTRIAL DEVELOPMENT ORGANIZATION

HELWAN IRON & STEEL PLANT
FLOW-SHEET — ALT 3 MODIFICATION

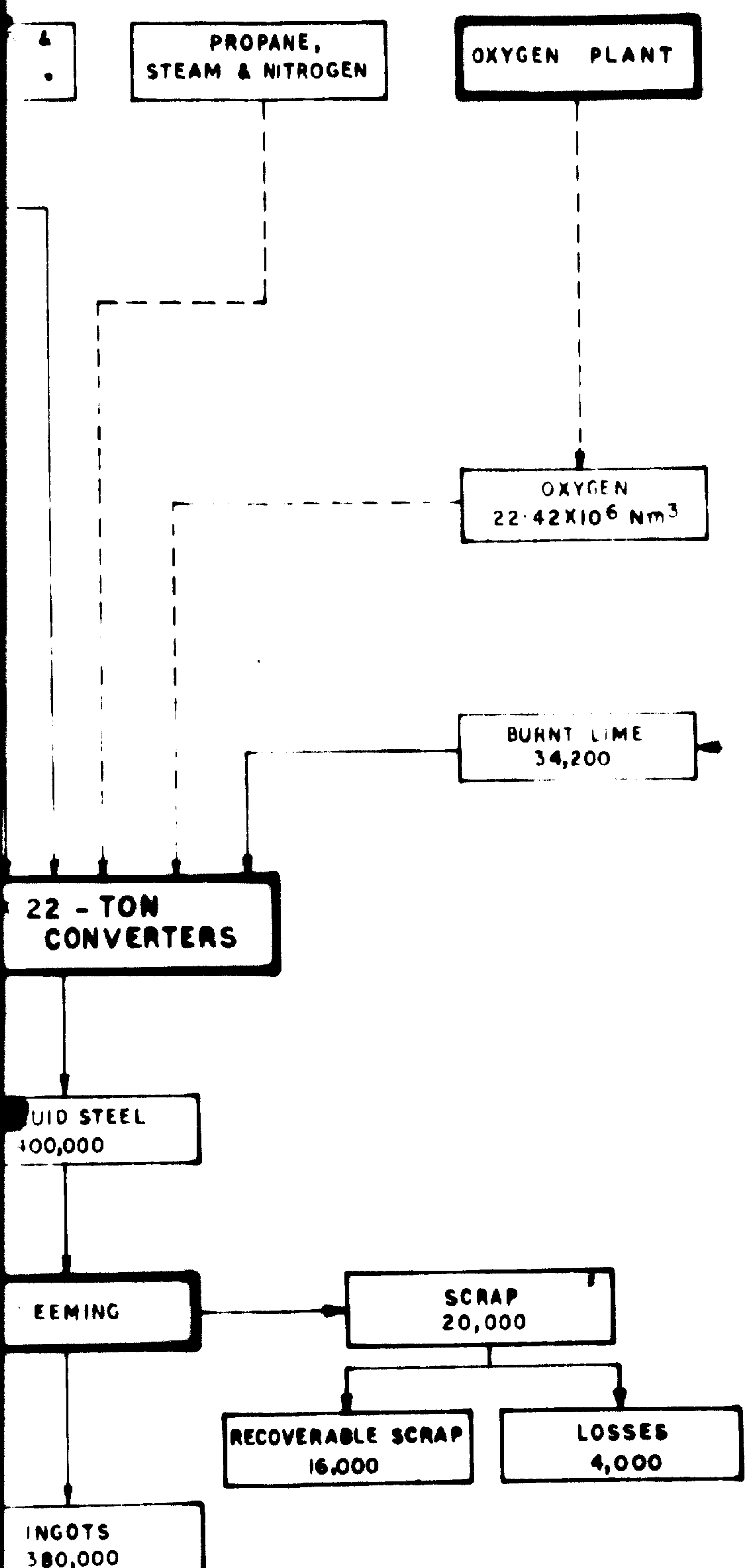
DRAWN	[signature]	29.5.72
APPROVED	[signature]	31.5.72

No. 519-3-3



SECTION 1

NOTE:
QUANTITIES IN TONS PER YEAR UNLESS OTHERWISE SPECIFIED



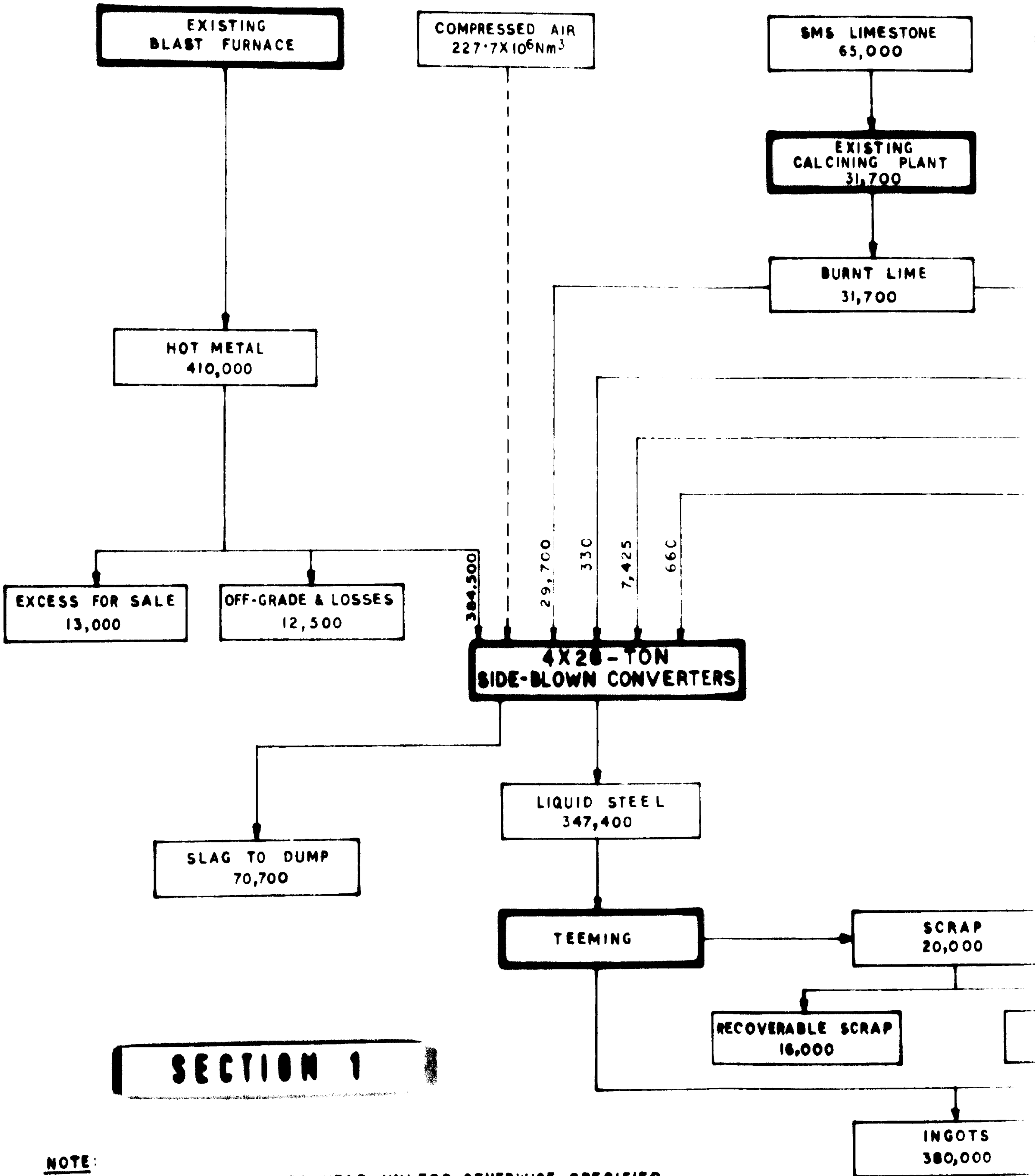
SECTION 2

DASTUR ENGINEERING INTERNATIONAL GmbH
CONSULTING ENGINEERS, DÜSSELDORF

FOR: UNITED NATIONS
INDUSTRIAL DEVELOPMENT ORGANIZATION

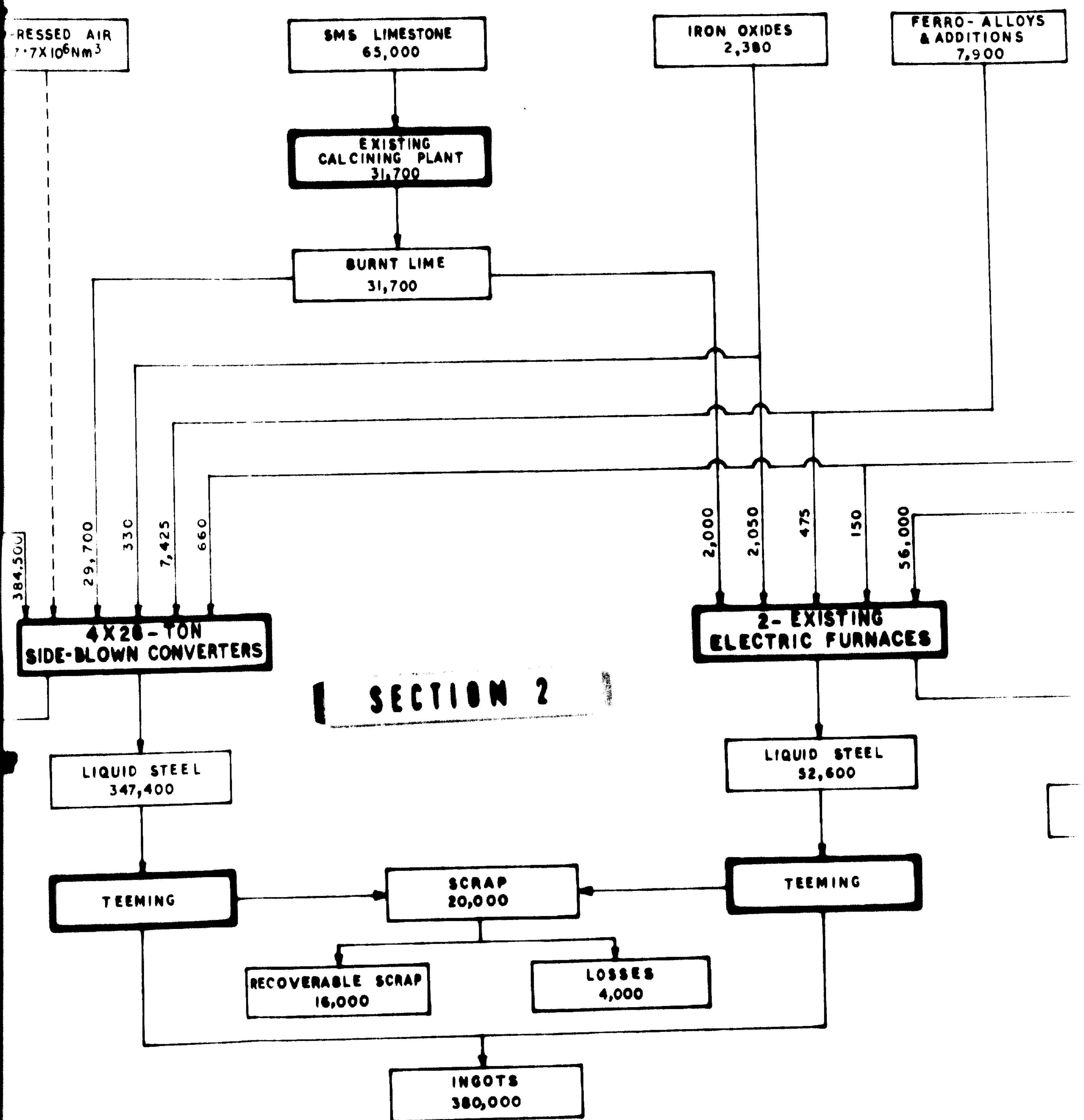
HELWAN IRON & STEEL PLANT
FLOW-SHEET — ALT. 4 MODIFICATION

DRAWN	M. Ghosh (signature)	2.6.72	No. 519-3-4
APPROVED	A. Lahiri (signature)	5.6.72	

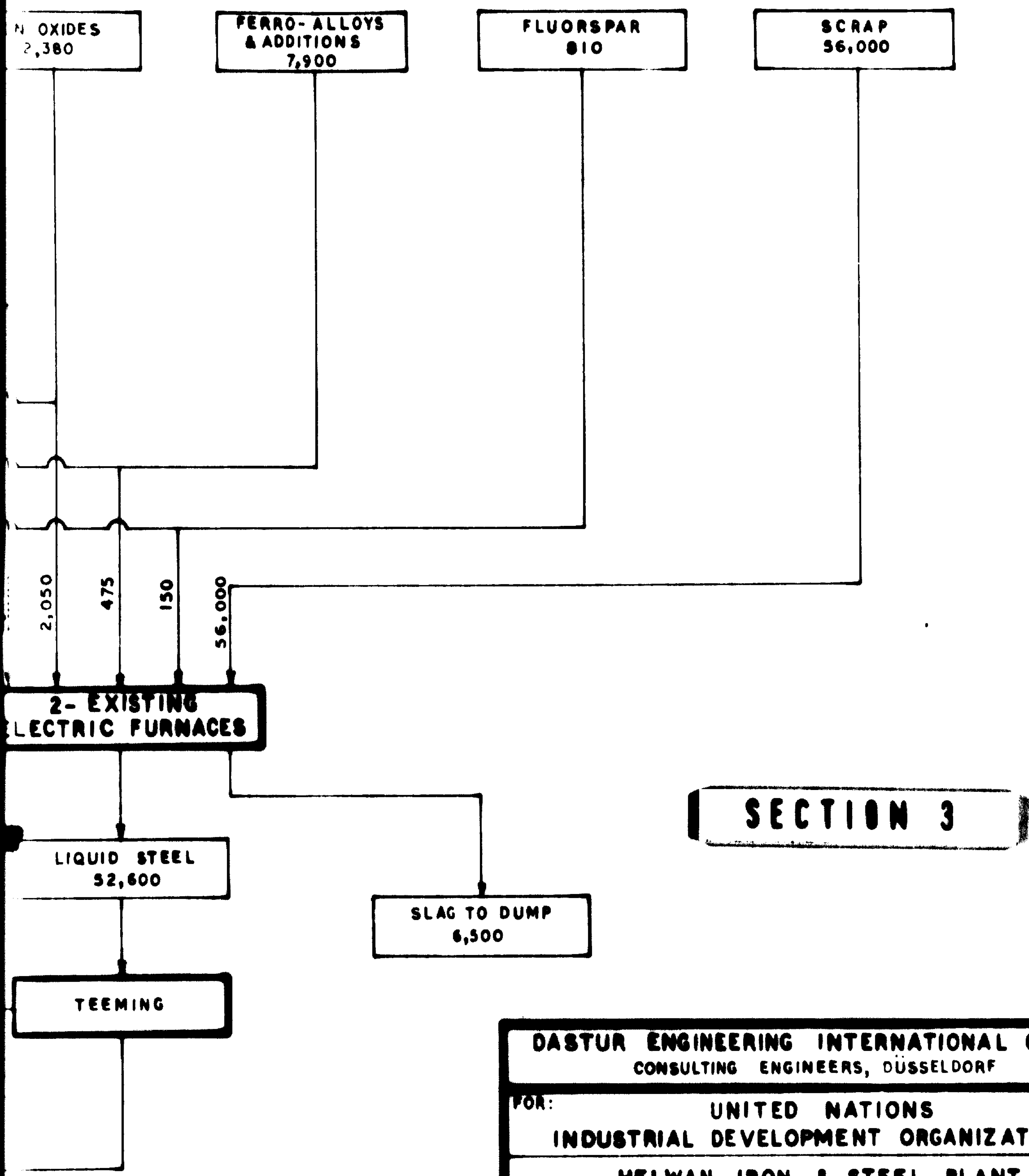


SECTION 1

NOTE:
QUANTITIES IN TONS PER YEAR UNLESS OTHERWISE SPECIFIED



OTHERWISE SPECIFIED

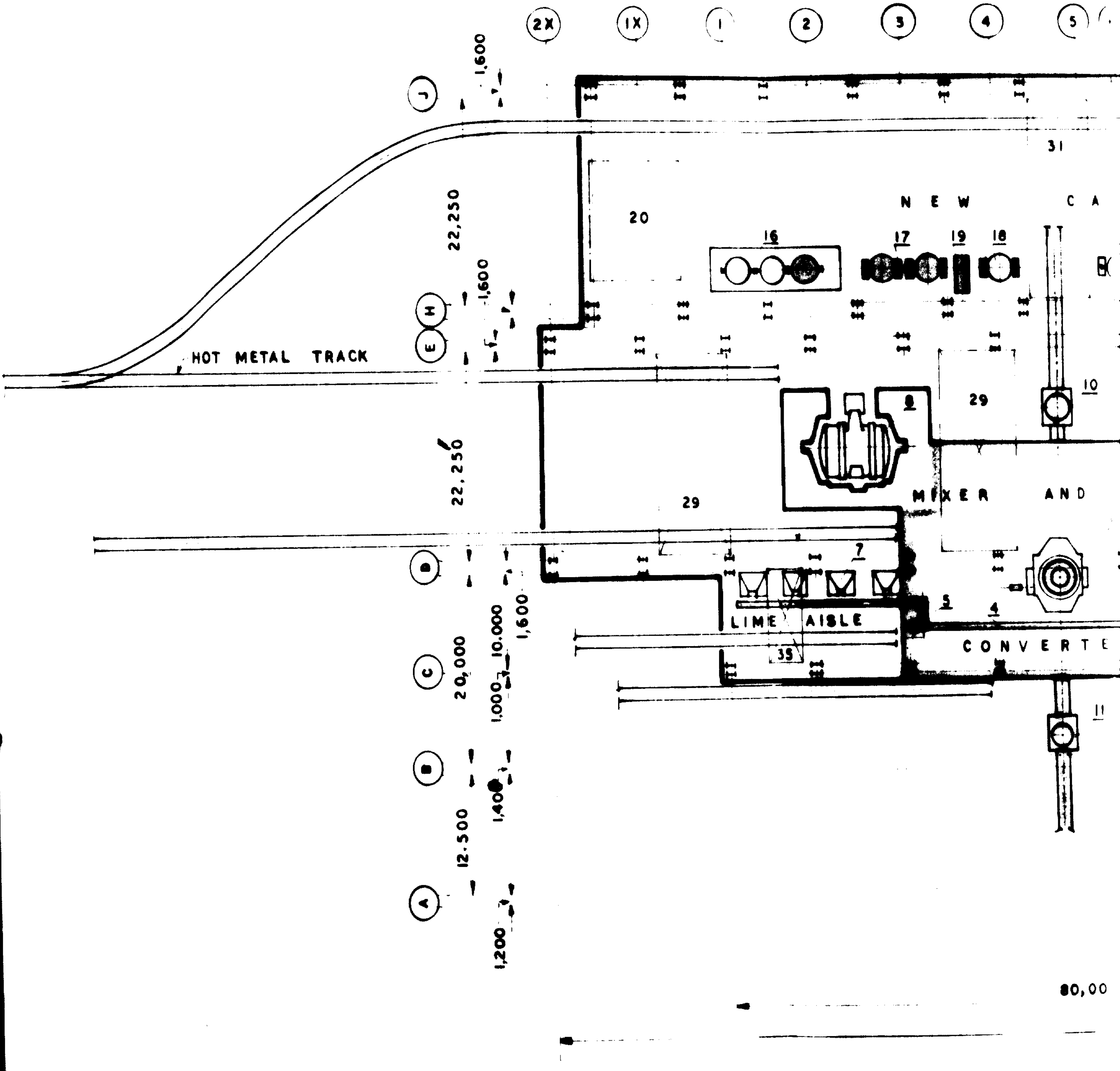


DASTUR ENGINEERING INTERNATIONAL GmbH
CONSULTING ENGINEERS, DÜSSELDORF

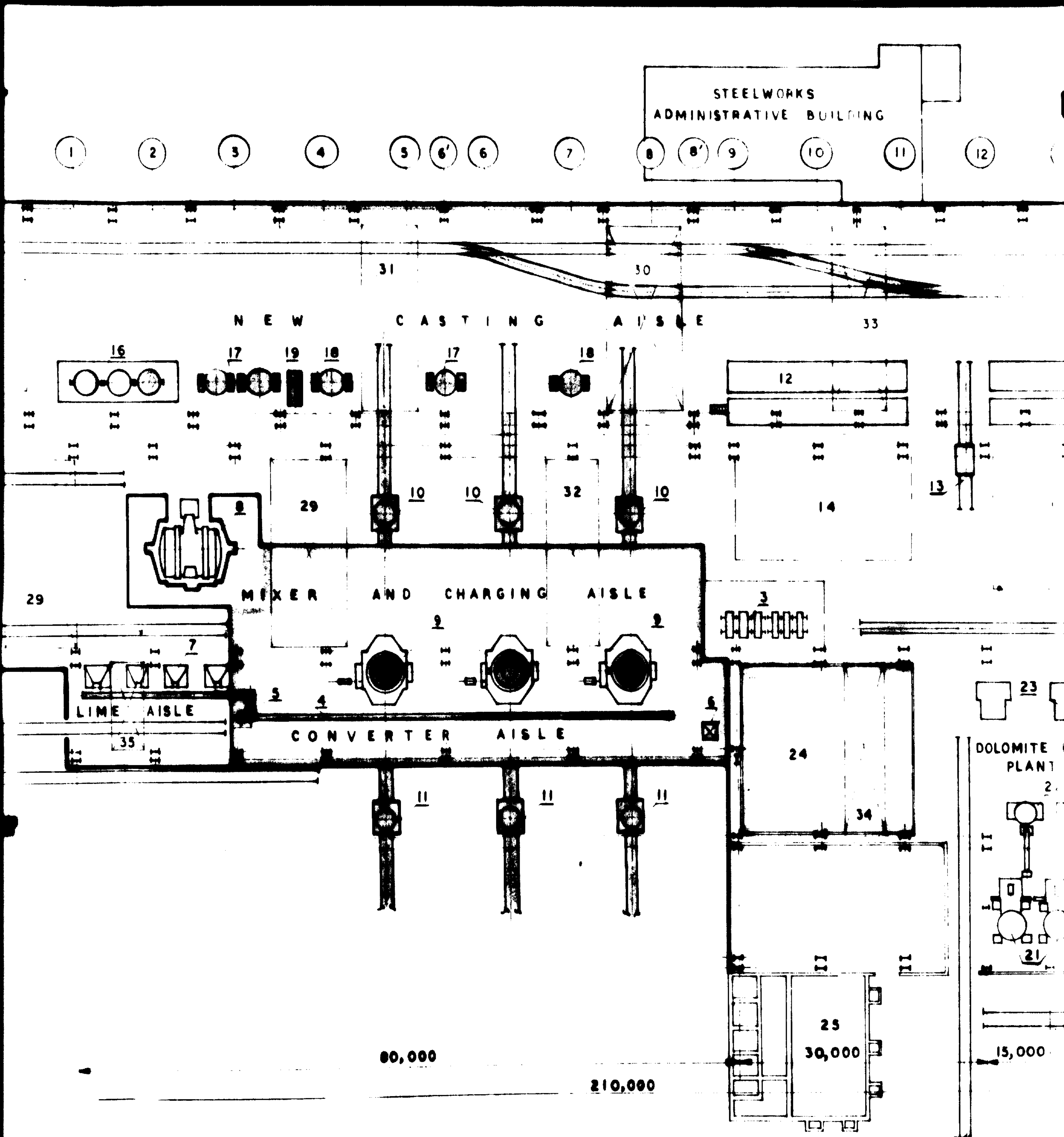
FOR: UNITED NATIONS
INDUSTRIAL DEVELOPMENT ORGANIZATION

HELWAN IRON & STEEL PLANT
FLOW-SHEET — ALT. 5 MODIFICATION

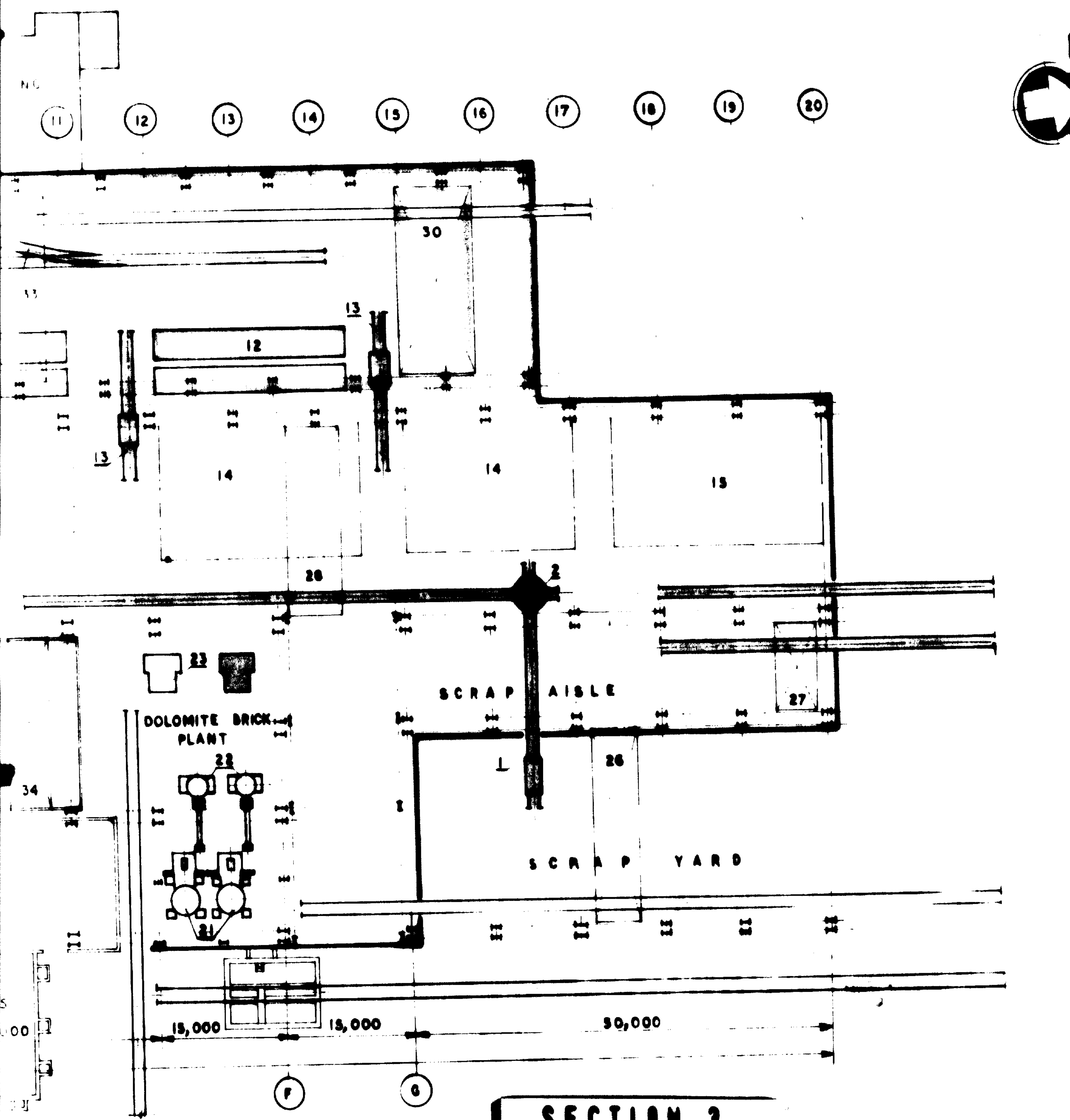
DRAWN	[signature]	8.6.72	No. 519-3-5
APPROVED	[signature]	12.6.72	


2X
1X
1
2
3
4
5
J
H
E
D
C
B
A
1,600
22,250
1,600
HOT METAL TRACK
22,250
20,000
1,000
10,000
1,600
12.500
1,400
1,200
31
N E W
C A
20
16
17
19
18
10
29
8
29
MIXER
AND
7
LIME AISLE
5
4
35
CONVERTE
11
80,00

SECTION 1


STEELWORKS
ADMINISTRATIVE BUILDING
1
2
3
4
5
6'
6
7
8
8'
9
10
11
12
31
30
33
NEW CASTING AISLE
16
17
19
18
17
18
12
10
10
32
10
29
14
13
8
29
MIXER AND CHARGING AISLE
9
9
3
7
LIME AISLE
35
5
4
6
CONVERTER AISLE
23
24
DOLOMITE
11
11
11
34
21
25
30,000
80,000
210,000
15,000

SECTION 2



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SCRAP AISLE
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DOLOMITE BRICK PLANT
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SCRAP YARD
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SECTION 3

N

LEGEND

1 SCRAP TRANSFER CAR
2 TURN TABLE
3 SCRAP BOX STORAGE AREA
4 ADDITIONS CONVEYOR
5 BUCKET ELEVATOR
6 FREIGHT ELEVATOR
7 ADDITIONS STORAGE BINS
8 500^T HOT METAL MIXER
9 20^T L D CONVERTER
10 STEEL TRANSFER CAR
11 SLAG POT CAR
12 INGOT CASTING AREA
13 MOULD TRANSFER
14 MOULD COOLING AND CLEANING AREA
15 STORAGE FOR NEW MOULDS
16 LADLE RELINING PIT
17 LADLE HEATING
18 LADLE STAND
19 STOPPER ROD OVEN
20 LADLE DESKULLING AREA
21 DOLOMITE SHAFT KILN
22 PAN MILL
23 BRICK PRESS
24 DOLOMITE BRICK STORAGE
25 ELECTRIC SWITCH HOUSE
26 5^T MAGNET CRANE
27 $16/3^T$ MAGNET CRANE (EXISTING CRANE MODIFIED)
28 10^T MOULD HANDLING CRANE
29 $50/10^T$ HOT METAL CHARGING CRANE
30 $50/10^T$ CASTING CRANE
31 $25/5^T$ LADLE CRANE (RELOCATED)
32 $25/5^T$ SCRAP CHARGING CRANE (EXISTING CRANE MODIFIED)
33 10^T STRIPPER CRANE (RELOCATED)
34 12.5^T OVERHEAD CRANE
35 3^T CRANE FOR LIME BUCKET

■ ADDITIONAL FACILITIES

SECTION 4

10 5 0 10 20 30 40

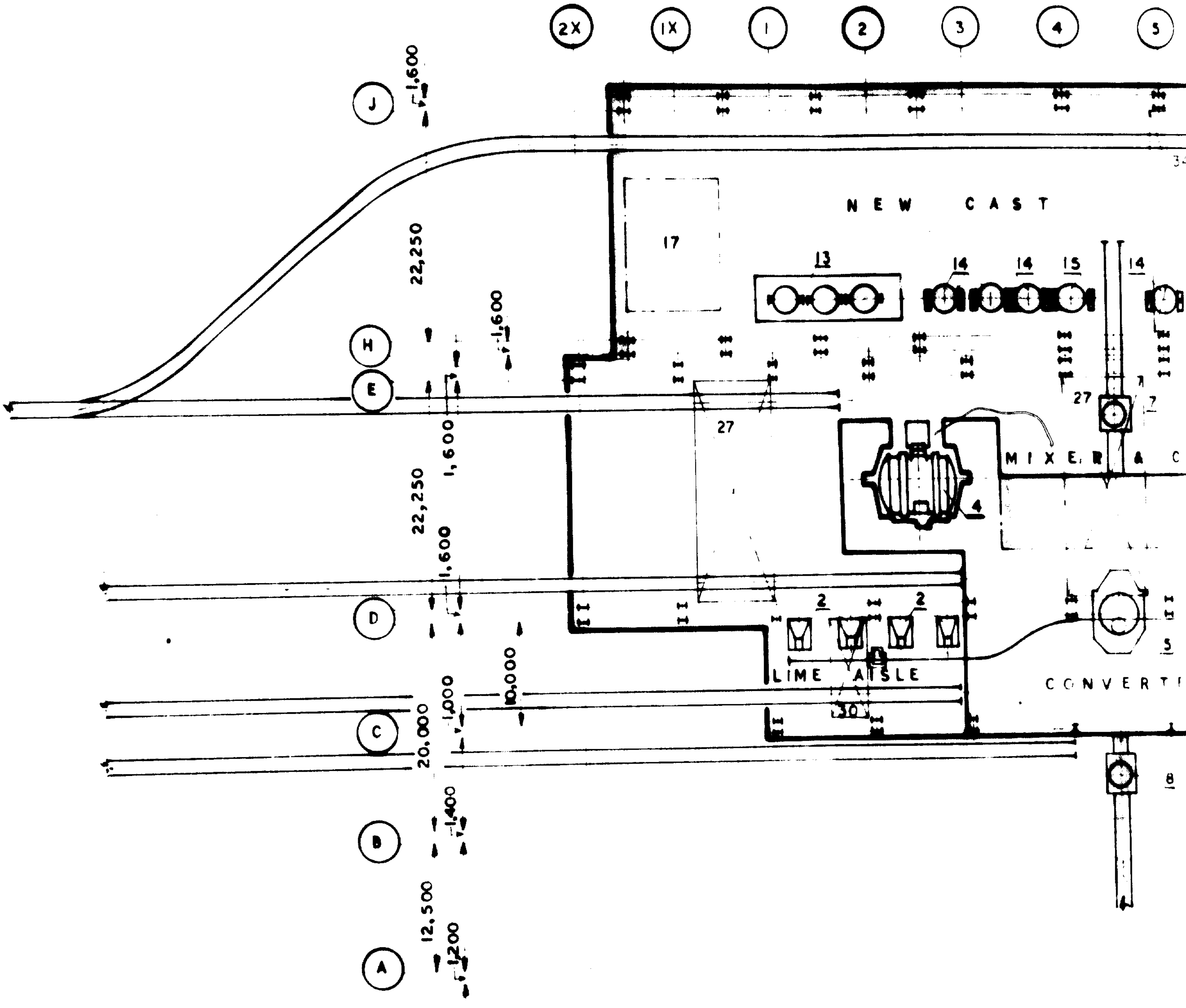
SCALE : METRES

DASTUR ENGINEERING INTERNATIONAL GmbH
CONSULTING ENGINEERS, DÜSSELDORF

FOR: UNITED NATIONS
INDUSTRIAL DEVELOPMENT ORGANIZATION

HELWAN IRON & STEEL PLANT
MODIFICATION TO STEELMELT SHOP – ALT. I

DRAWN	[illegible]	8.5.72	No. 519-4-1
APPROVED	[illegible]	11.5.72	



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CONVERT
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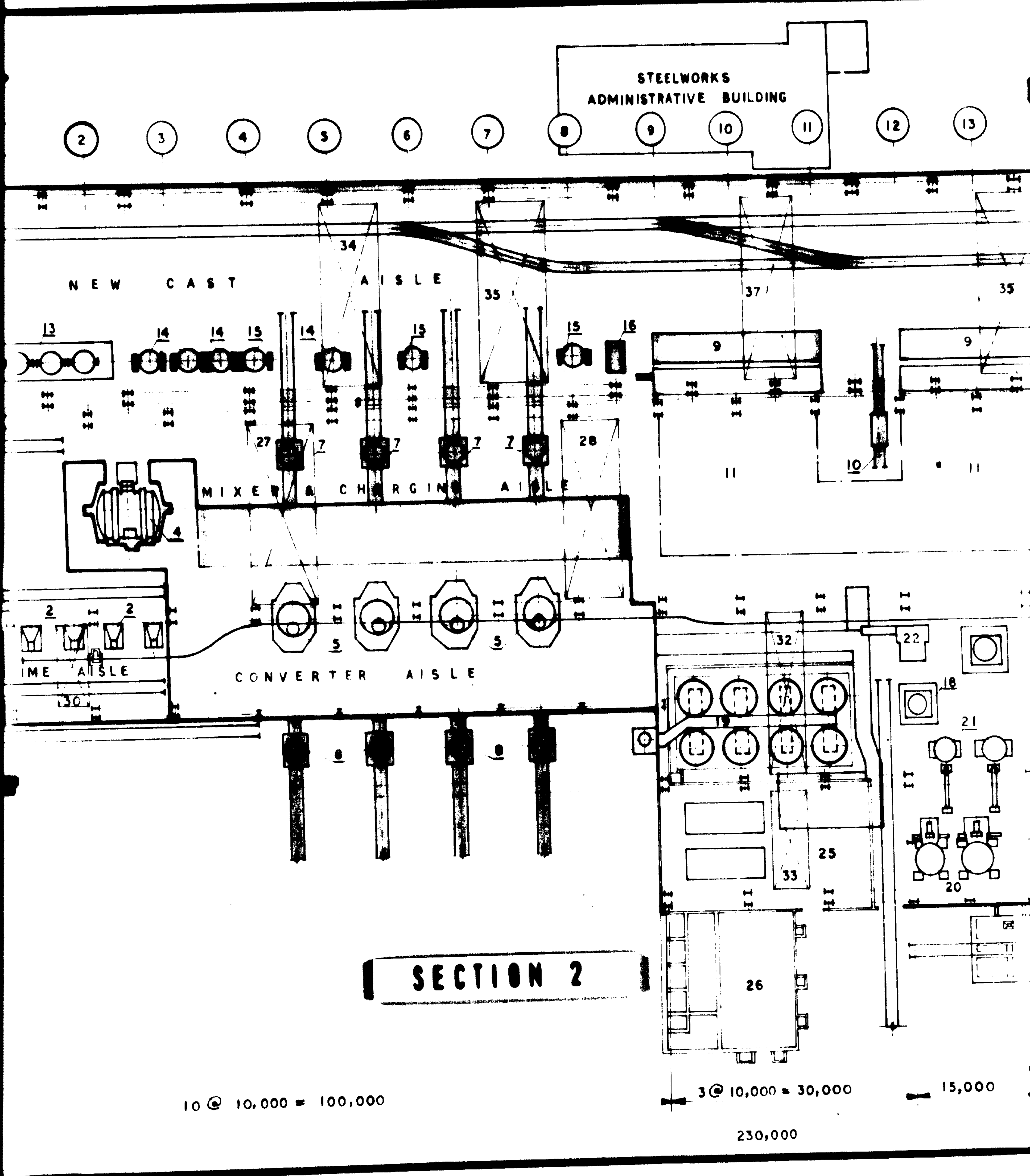
10 @ 10,000 =

SECTION 1


STEELWORKS
ADMINISTRATIVE BUILDING
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NEW CAST AISLE
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MIXER & CHARGING AISLE
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IME AISLE
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CONVERTER AISLE
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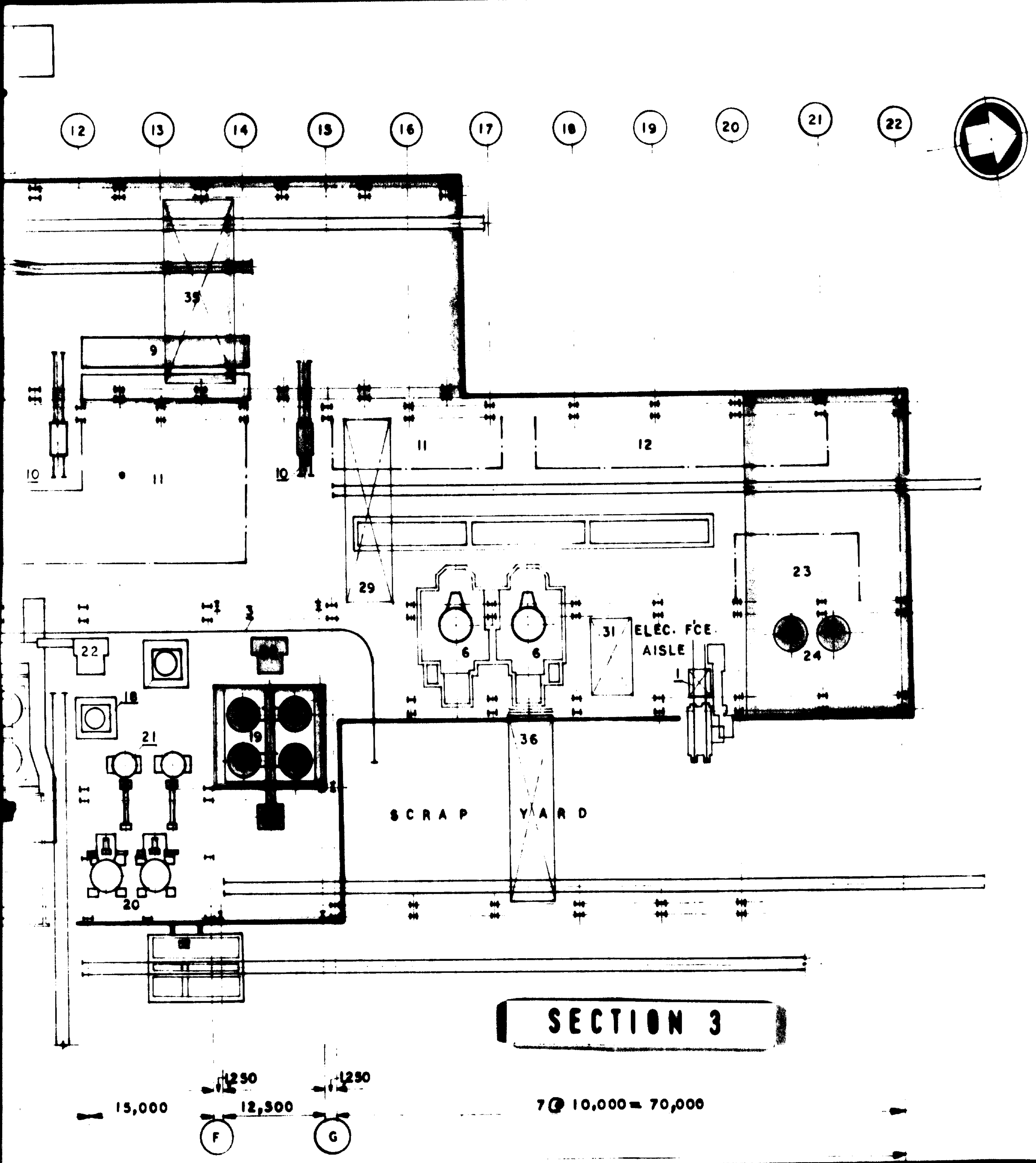
SECTION 2
10 @ 10,000 = 100,000
3 @ 10,000 = 30,000
15,000
230,000



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36
SCRAP YARD
SECTION 3
1250
1250
15,000
12,500
7@ 10,000 = 70,000
F
G

N

LEGEND

1 SCRAP BASKET CAR
2 ADDITIONS STORAGE BINS
3 MONORAIL TRACK
4 500^T HOT METAL MIXER
5 EXISTING THOMAS CONVERTER
6 12^T ELECTRIC FURNACE
7 STEEL TRANSFER CAR
8 SLAG POT CAR
9 INGOT CASTING AREA
10 MOULD TRANSFER
11 MOULD COOLING AND CLEANING AREA
12 STORAGE FOR NEW MOULDS
13 LADLE RELINING PIT
14 LADLE HEATING
15 LADLE STAND
16 STOPPER ROD OVEN
17 LADLE DESKULLING AREA
18 CONVERTER BOTTOM RAMMING MACHINE
19 CONVERTER BOTTOM BURNING OVEN
20 DOLOMITE SHAFT KILN
21 PAN MILL
22 BRICK PRESS
23 ELECTRIC FURNACE LADLE PREPARATION AREA
24 ELECTRIC FURNACE ROOF RELINING AREA
25 BLOWER, POWER, WATER & COMPRESSOR PLANT
26 ELECTRIC SWITCH HOUSE
27 $50/10^T$ HOT METAL CHARGING CRANE
28 10^T MOULD HANDLING CRANE
29 $25/5^T$ LADLE CRANE
30 3^T CRANE FOR LIME BUCKET
31 $16/3^T$ ELECTRIC FURNACE CHARGING CRANE
32 $12{\cdot}5^T$ OVERHEAD CRANE
33 20^T OVERHEAD CRANE
34 $25/5^T$ LADLE CRANE (RELOCATED)
35 $50/10^T$ TEEMING CRANE
36 8^T MAGNET CRANE
37 10^T STRIPPER CRANE (RELOCATED)

SECTION 4

■ ADDITIONAL FACILITIES

10 5 0 10 20 30 40

SCALE : METRES

DASTUR ENGINEERING INTERNATIONAL GmbH
CONSULTING ENGINEERS, DÜSSELDORF

FOR: UNITED NATIONS
INDUSTRIAL DEVELOPMENT ORGANIZATION

HELWAN IRON & STEEL PLANT
MODIFICATION TO STEELMELT SHOP — ALT. 2

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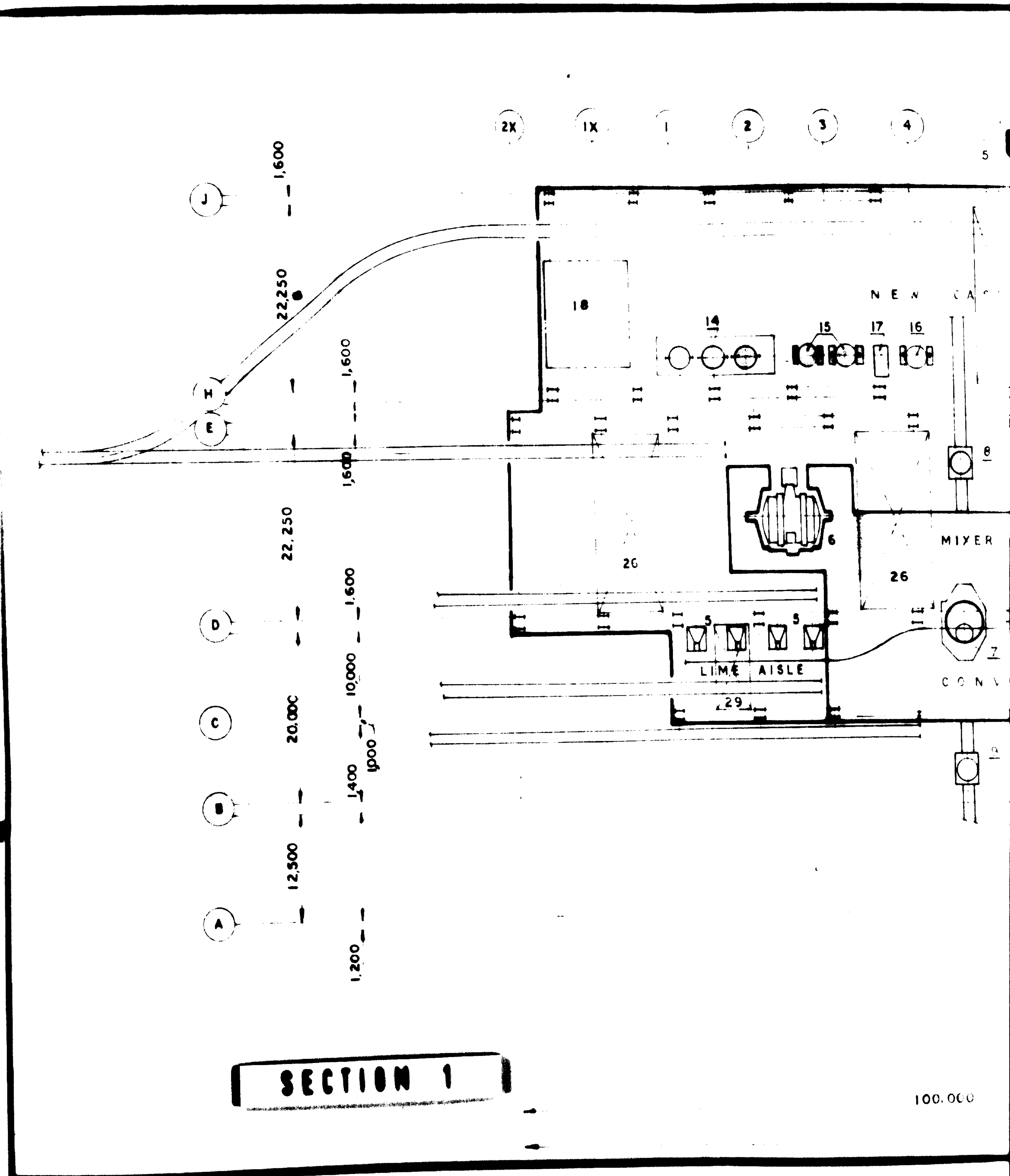
APPROVED	[signature]	8.6.72	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LIME AISLE
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SECTION 1
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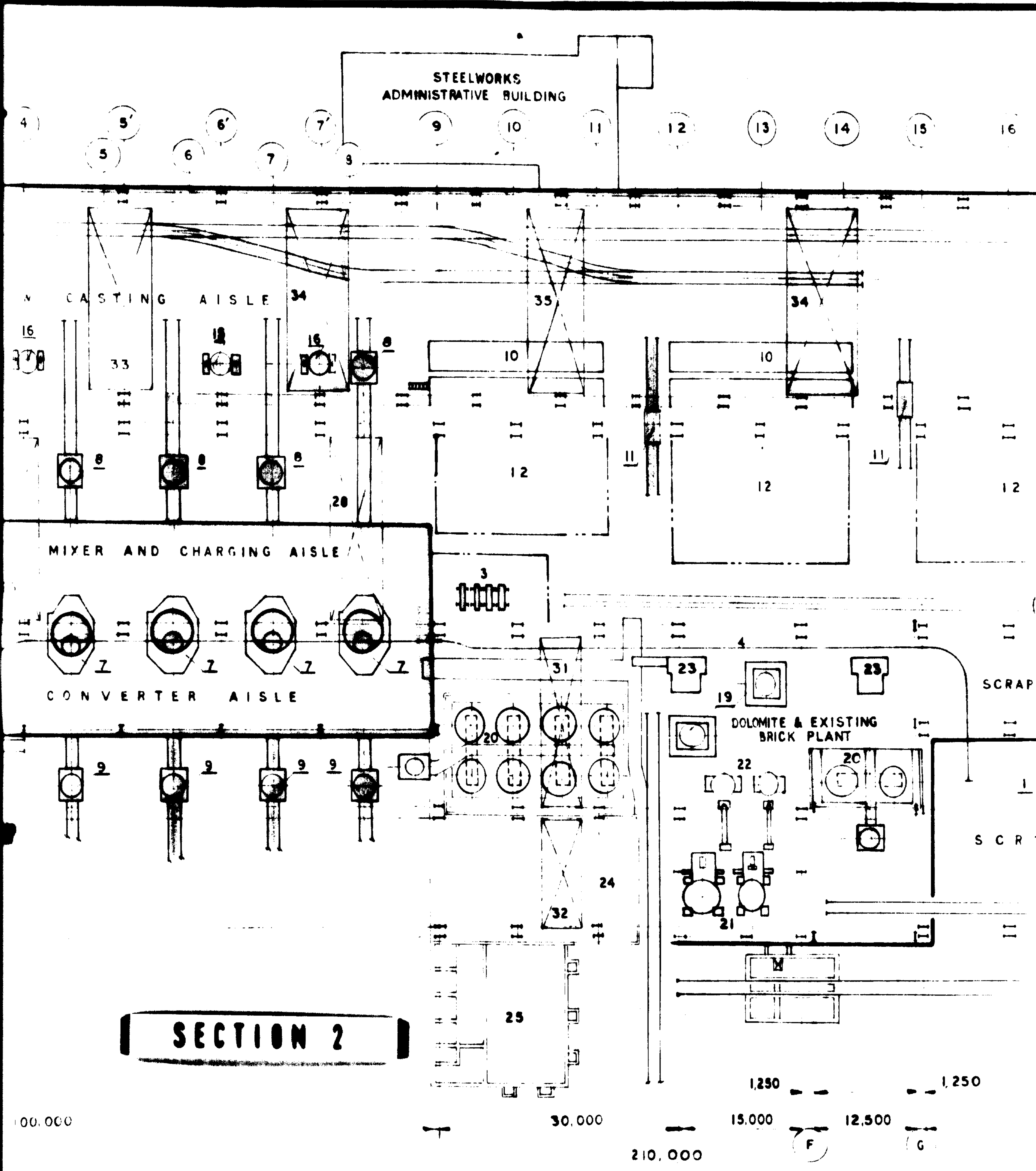

STEELWORKS
ADMINISTRATIVE BUILDING
CASTING AISLE
MIXER AND CHARGING AISLE
CONVERTER AISLE
DOLOMITE & EXISTING BRICK PLANT
SCRAP
SECTION 2
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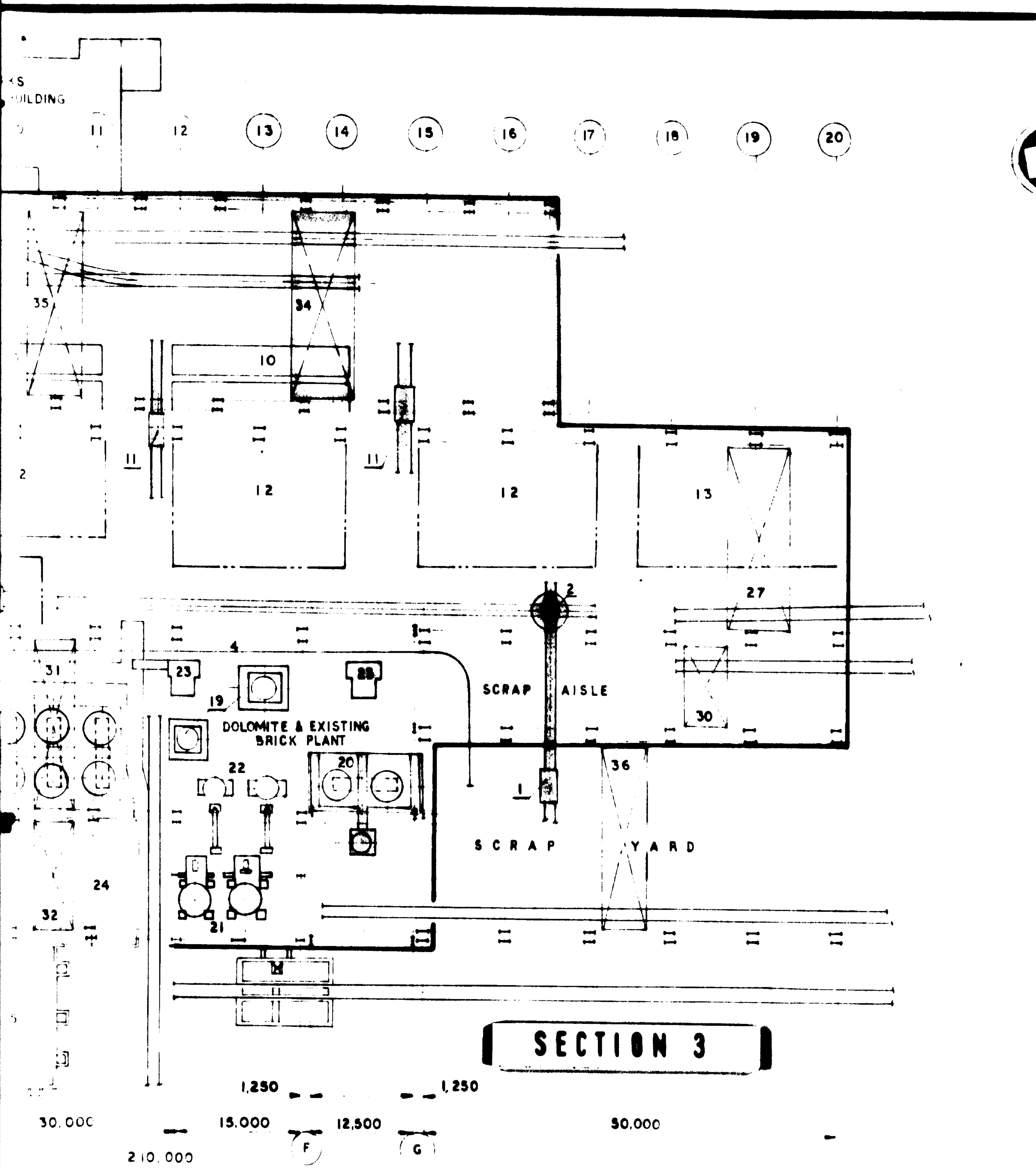

BUILDING
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SCRAP
AISLE
DOLOMITE & EXISTING
BRICK PLANT
31
22
20
36
1
30
SCRAP
YARD
24
32
21
SECTION 3
1,250
1,250
30,000
15,000
12,500
50,000
210,000
F
G

LEGEND

N

SECTION 4

1. SCRAP TRANSFER CAR
2. TURN TABLE
3. SCRAP BOX STORAGE AREA
4. MONORAIL TRACK
5. FLUX STORAGE BINS
6. 500^T HOT METAL MIXER
7. 24^T THOMAS CONVERTER
8. STEEL TRANSFER CAR
9. SLAG POT CAR
10. INGOT CASTING AREA
11. MOULD TRANSFER CAR
12. MOULD COOLING & CLEANING AREA
13. STORAGE FOR NEW MOULDS
14. LADLE RELINING PIT
15. LADLE HEATING
16. LADLE STAND
17. STOPPER ROD OVEN
18. LADLE DESKULLING
19. CONVERTER BOTTOM RAMMING MACHINE
20. CONVERTER BOTTOM BURNING OVEN
21. DOLOMITE SHAFT KILN
22. PAN MILL
23. BRICK PRESS
24. BLOWER, POWER, WATER & COMPRESSOR PLANT .
25. ELECTRIC SWITCH HOUSE
26. $50/10^T$ HOT METAL CHARGING CRANE
27. 10^T MOULD HANDLING CRANE
28. $25/5^T$ SCRAP CHARGING CRANE
29. 3^T CRANE FOR LIME BUCKET
30. $16/3^T$ MAGNET CRANE (EXISTING CRANE MODIFIED)
31. 12.5^T OVERHEAD CRANE
32. 20^T OVERHEAD CRANE
33. $25/5^T$ LADLE CRANE (RELOCATED)
34. $50/10^T$ TEEMING CRANE
35. 10^T STRIPPER CRANE (RELOCATED)
36. 8^T MAGNET CRANE

ADDITIONAL FACILITIES

10 5 0 10 20 30 40

SCALE: METRES

DASTUR ENGINEERING INTERNATIONAL GmbH
CONSULTING ENGINEERS , DÜSSELDORF

FOR: UNITED NATIONS
INDUSTRIAL DEVELOPMENT ORGANIZATION

HELWAN IRON & STEEL PLANT
MODIFICATION TO STEELMELT SHOP — ALT. 3

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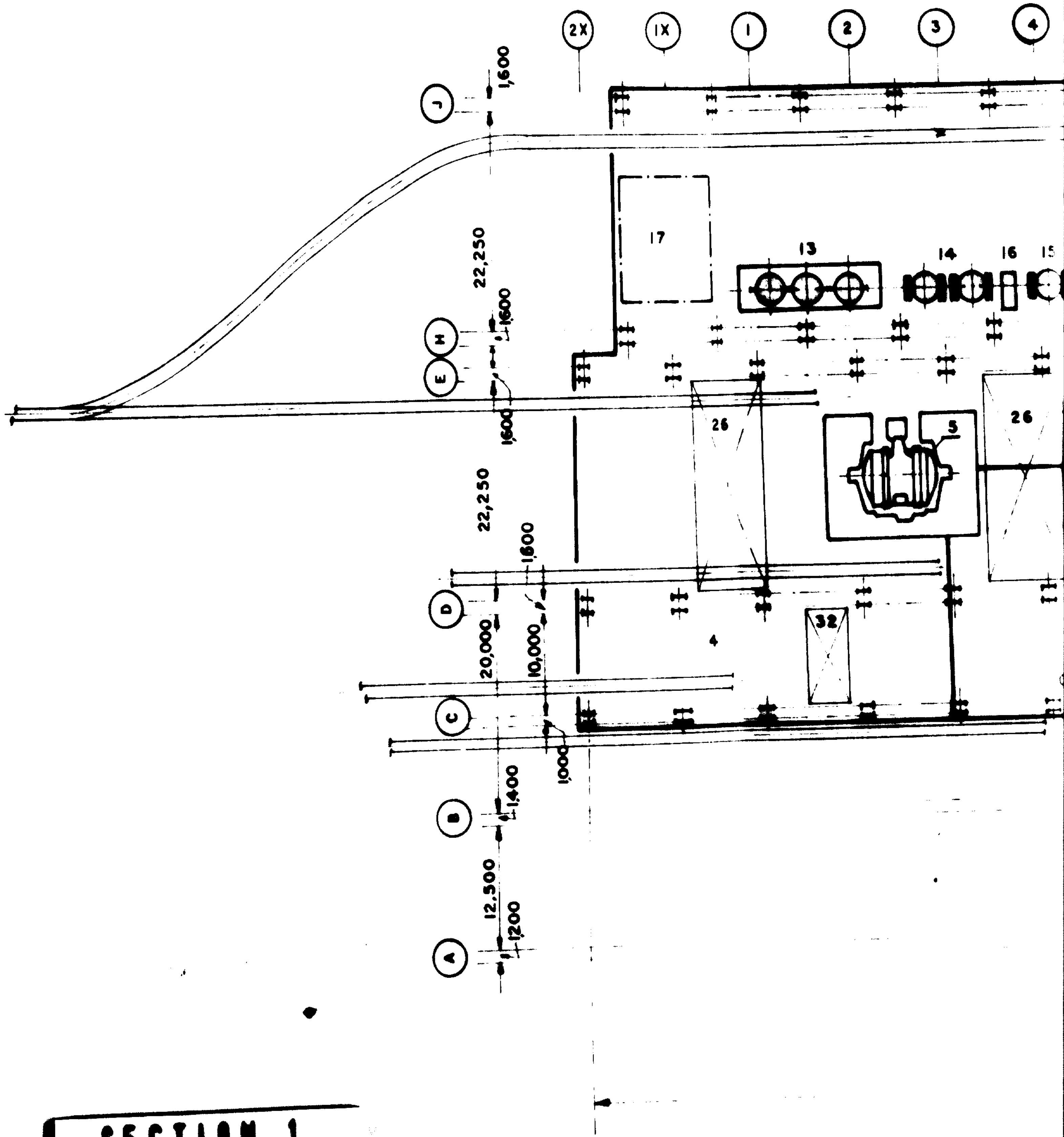
APPROVED	[illegible]	[illegible]	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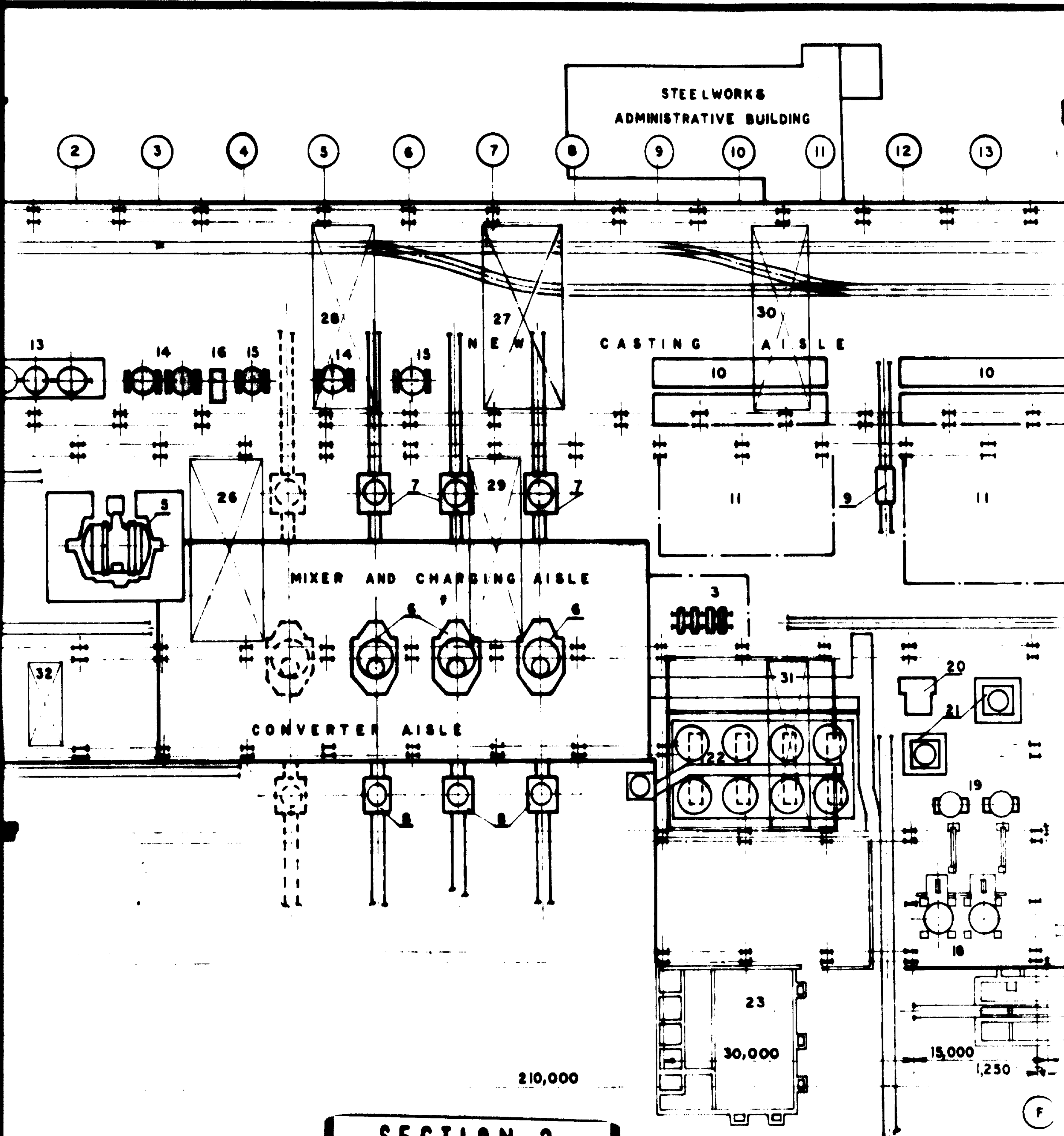
SECTION 1


STEELWORKS
ADMINISTRATIVE BUILDING
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NEW CASTING AISLE
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MIXER AND CHARGING AISLE
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CONVERTER AISLE
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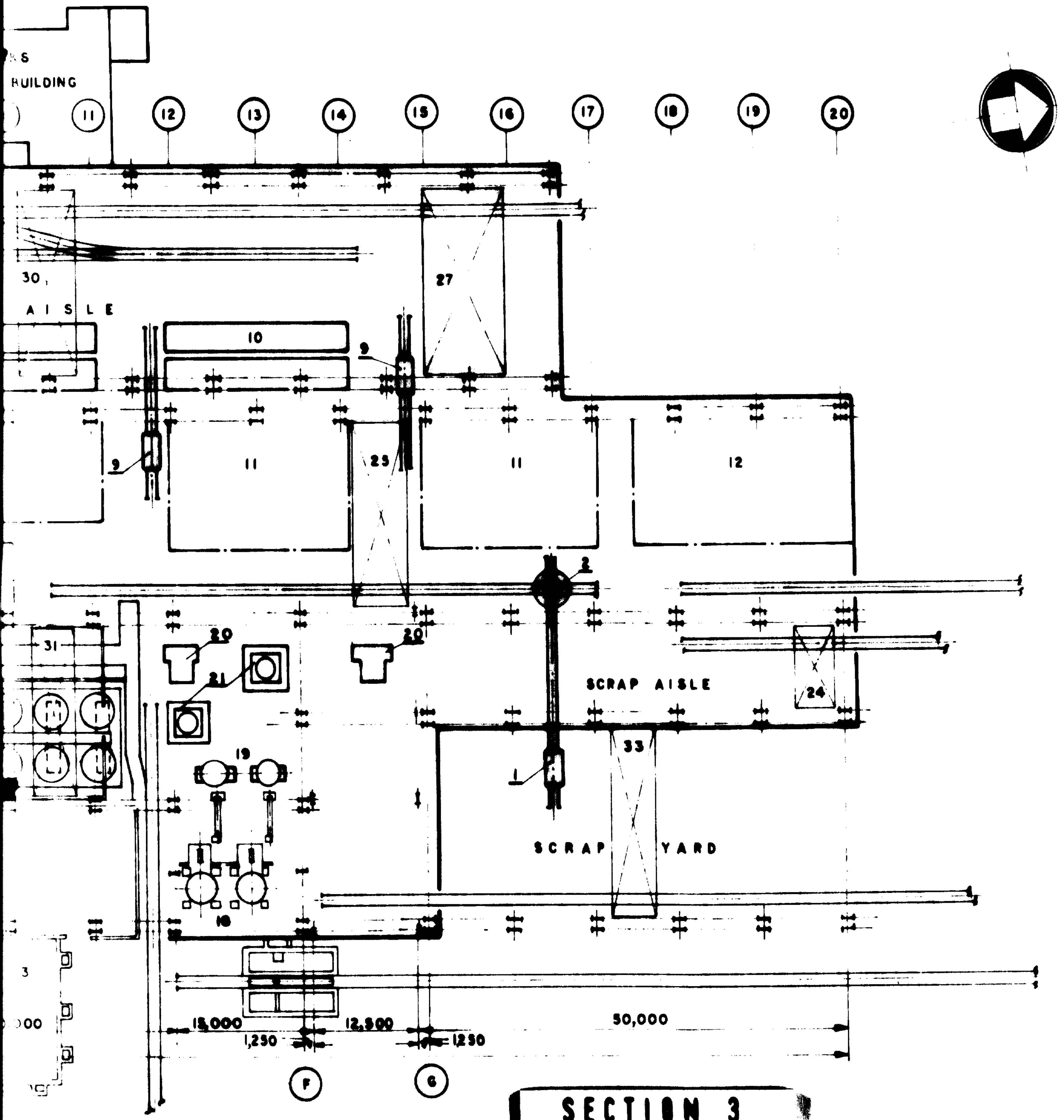
SECTION 2



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BUILDING
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SECTION 3

N

LEGEND

1 SCRAP TRANSFER CAR
2 TURN TABLE
3 SCRAP BOX STORAGE AREA
4 FLUX GRINDING PLANT
5 300^{T} HOT METAL MIXER
6 22^{T} OBM CONVERTER
7 STEEL TRANSFER CAR
8 SLAG POT CAR
9 MOULD TRANSFER
10 INGOT CASTING AREA
11 MOULD COOLING & CLEANING AREA
12 STORAGE FOR NEW MOULDS
13 LADLE RELINING PIT
14 LADLE HEATING
15 LADLE STAND
16 STOPPER ROD OVEN
17 LADLE DESKULLING AREA
18 DOLOMITE SHAFT KILN
19 PAN MILL
20 BRICK PRESS
21 CONVERTER BOTTOM RAMMING MACHINE
22 CONVERTER BOTTOM BURNING OVEN
23 ELECTRIC SWITCH HOUSE
24 16/3^{T} MAGNET CRANE (EXISTING CRANE MODIFIED)
25 10^{T} MOULD HANDLING CRANE
26 80/10^{T} HOT METAL CHARGING CRANE
27 50/10^{T} CASTING CRANE
28 25/5^{T} LADLE CRANE (RELOCATED)
29 25/5^{T} SCRAP CHARGING CRANE
30 STRIPPER CRANE (RELOCATED)
31 12·5^{T} OVERHEAD TRAVELLING CRANE
32 3^{T} CRANE FOR FLUX GRINDING PLANT
33 8^{T} MAGNET CRANE

SECTION 4

ADDITIONAL FACILITIES

10 5 0 10 20 30 40

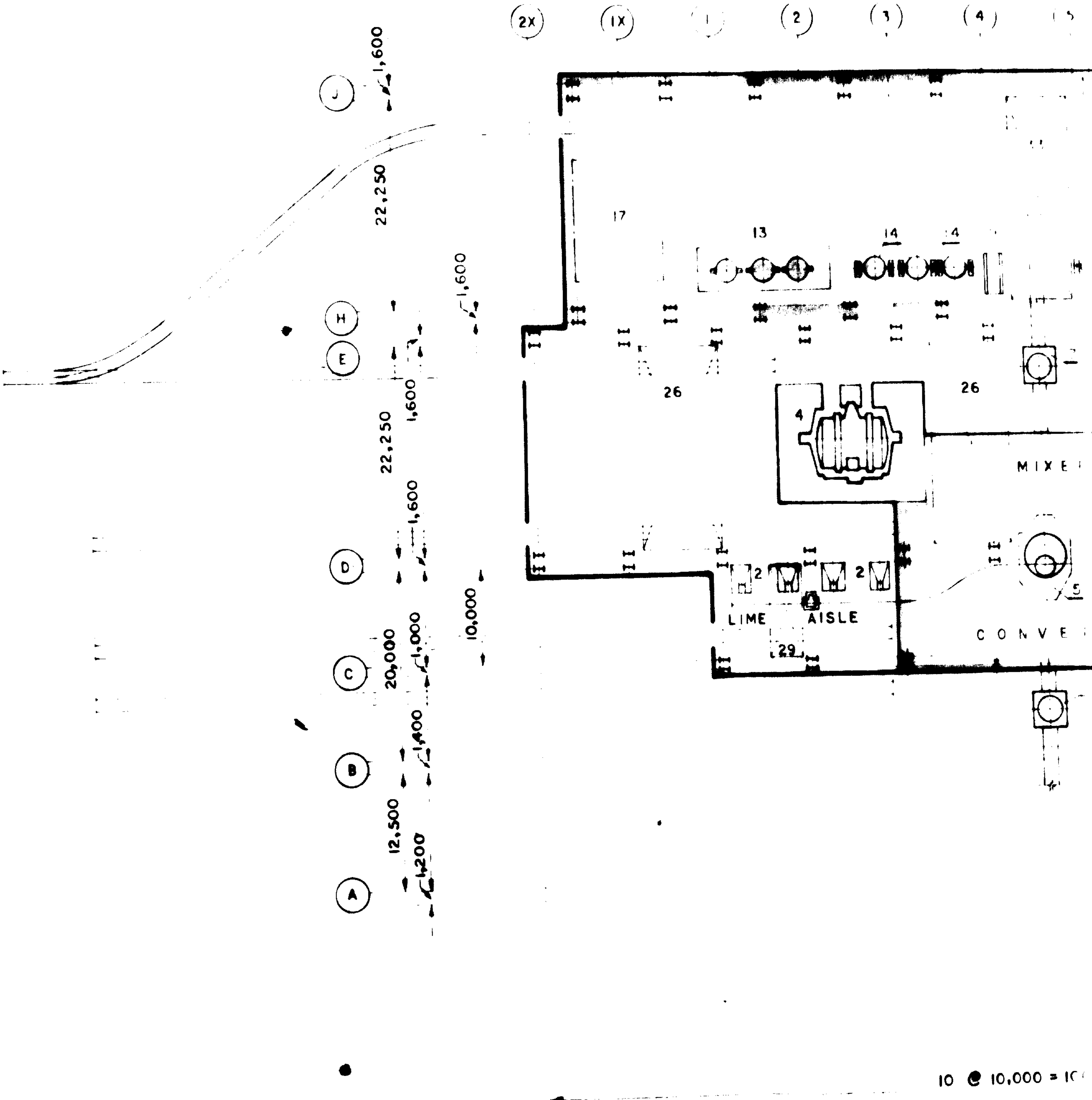
SCALE: METRES

DASTUR ENGINEERING INTERNATIONAL GmbH
CONSULTING ENGINEERS, DÜSSELDORF

FOR: UNITED NATIONS
INDUSTRIAL DEVELOPMENT ORGANIZATION

HELWAN IRON & STEEL PLANT
MODIFICATION TO STEELMELT SHOP — ALT. 4

DRAWN	[signature]	11.5.72	No. 519-4-4
APPROVED	[signature]	15.5.72	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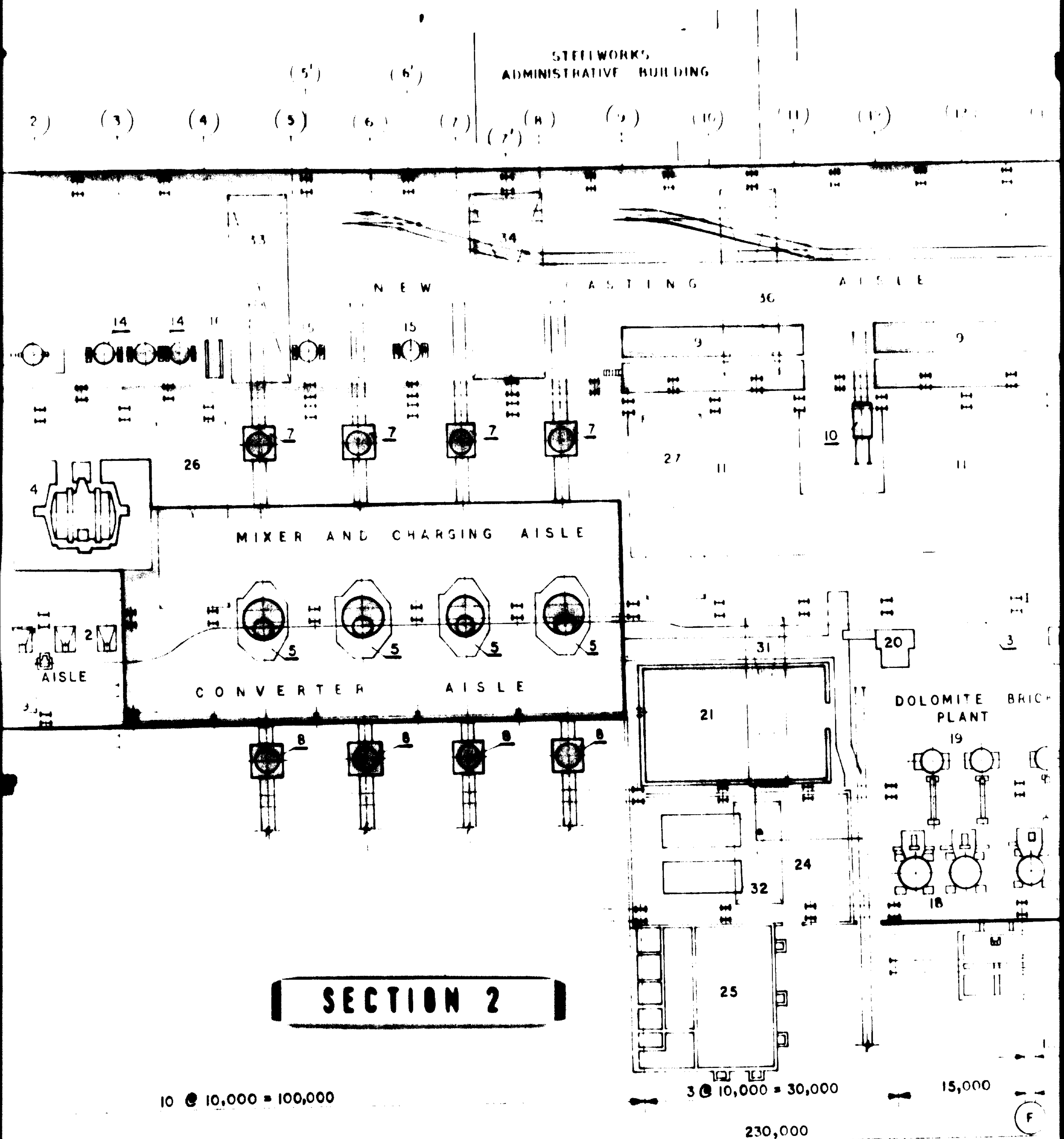
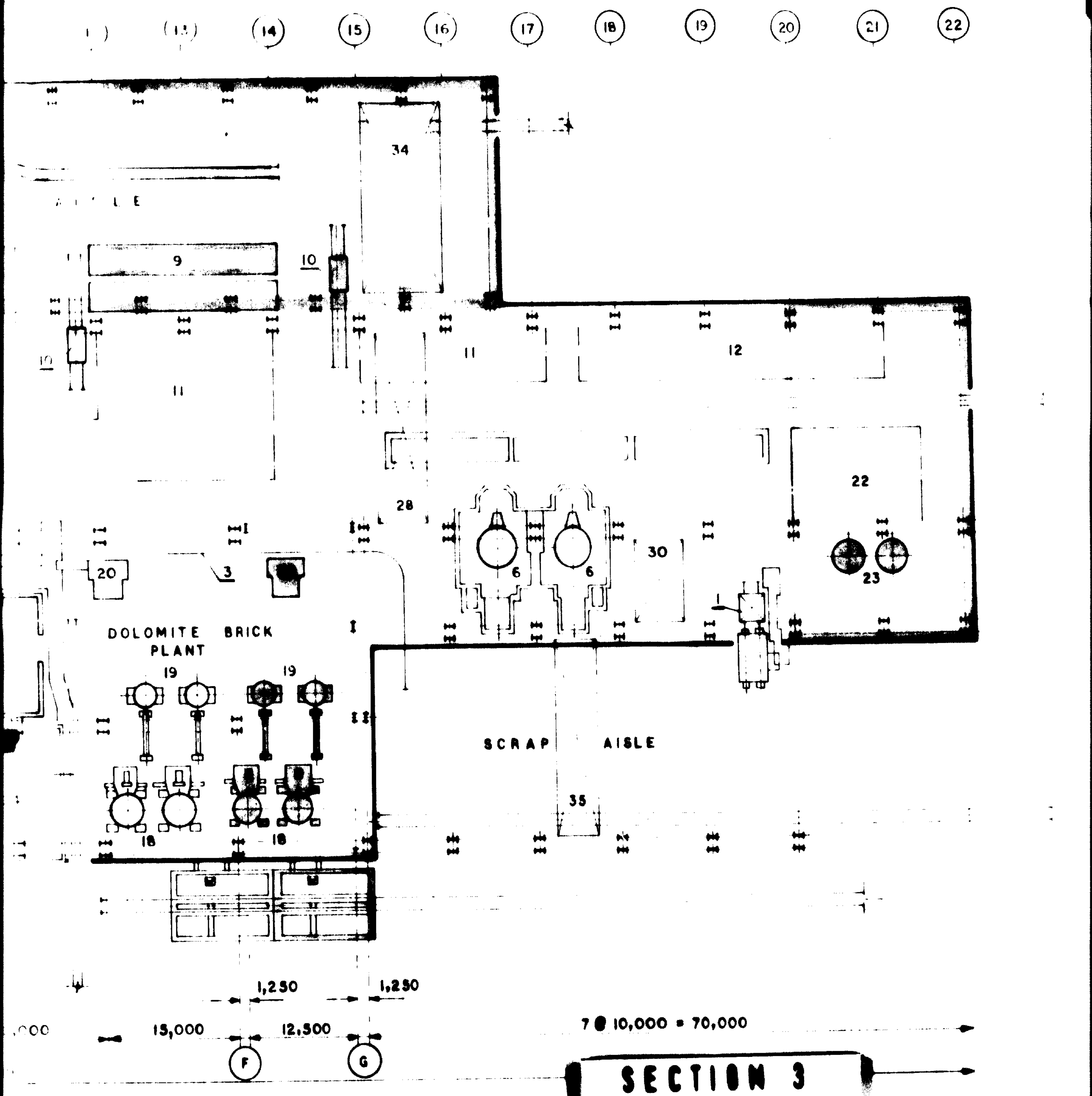
10 @ 10,000 = 1(

SECTION 1



STEELWORKS ADMINISTRATIVE BUILDING
NEW CASTING AISLE
MIXER AND CHARGING AISLE
CONVERTER AISLE
AISLE
DOLOMITE BRICK PLANT
SECTION 2
10 @ 10,000 = 100,000
3 @ 10,000 = 30,000
15,000
230,000



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DOLOMITE BRICK
PLANT
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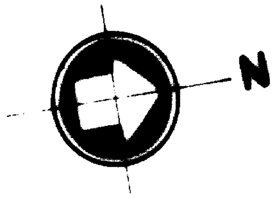
SCRAP AISLE
35
1,250
1,250
15,000
12,500
7 @ 10,000 = 70,000
F
G

SECTION 3



LEGEND

1 SCRAP BASKET CAR
2 ADDITIONS STORAGE BINS
3 MONORAIL TRACK
4 500^T HOT METAL MIXER
5 28^T BASIC SIDE-BLOWN CONVERTER
6 12^T ELECTRIC FURNACE
7 STEEL TRANSFER CAR
8 SLAG POT CAR
9 INGOT CASTING AREA
10 MOULD TRANSFER
11 MOULD COOLING & CLEANING AREA
12 STORAGE FOR NEW MOULDS
13 LADLE RELINING PIT
14 LADLE HEATING
15 LADLE STAND
16 STOPPER ROD OVEN
17 LADLE DESKULLING AREA
18 DOLOMITE SHAFT KILN
19 PAN MILL
20 BRICK PRESS
21 DOLOMITE BRICK STORAGE
22 ELECTRIC FURNACE LADLE PREPARATION AREA
23 ELECTRIC FURNACE ROOF RELINING AREA
24 BLOWER, POWER, WATER & COMPRESSOR PLANT
25 ELECTRIC SWITCH HOUSE
26 $50/10^T$ HOT METAL CHARGING CRANE
27 10^T MOULD HANDLING CRANE
28 $25/5^T$ LADLE CRANE
29 3^T CRANE FOR LIME BUCKET
30 $16/3^T$ ELECTRIC FURNACE CHARGING CRANE
31 12.5^T OVERHEAD CRANE
32 20^T OVERHEAD CRANE
33 $25/5^T$ LADLE CRANE (RELOCATED)
34 $50/10^T$ TEEMING CRANE
35 8^T MAGNET CRANE
36 10^T STRIPPER CRANE (RELOCATED)

ADDITIONAL FACILITIES

10 5 0 10 20 30 40

SCALE : METRES

SECTION 4

DASTUR ENGINEERING INTERNATIONAL GmbH
CONSULTING ENGINEERS, DÜSSELDORF

FOR: UNITED NATIONS INDUSTRIAL DEVELOPMENT ORGANIZATION

HELWAN IRON & STEEL PLANT
MODIFICATION TO STEELMELT SHOP — ALT. 5

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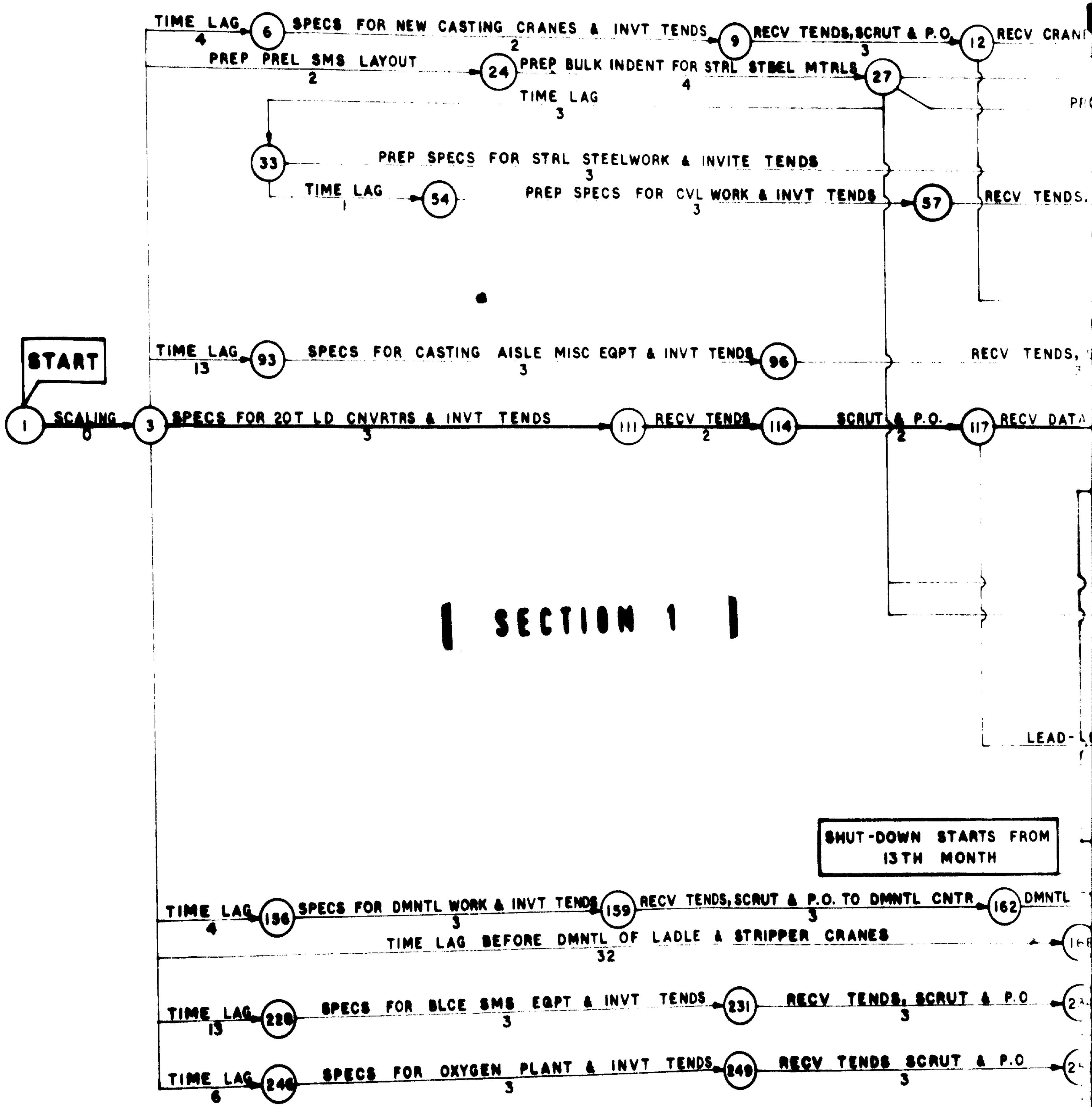
APPROVED	[illegible]	9.5.72

No. 519-4-5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SCALING
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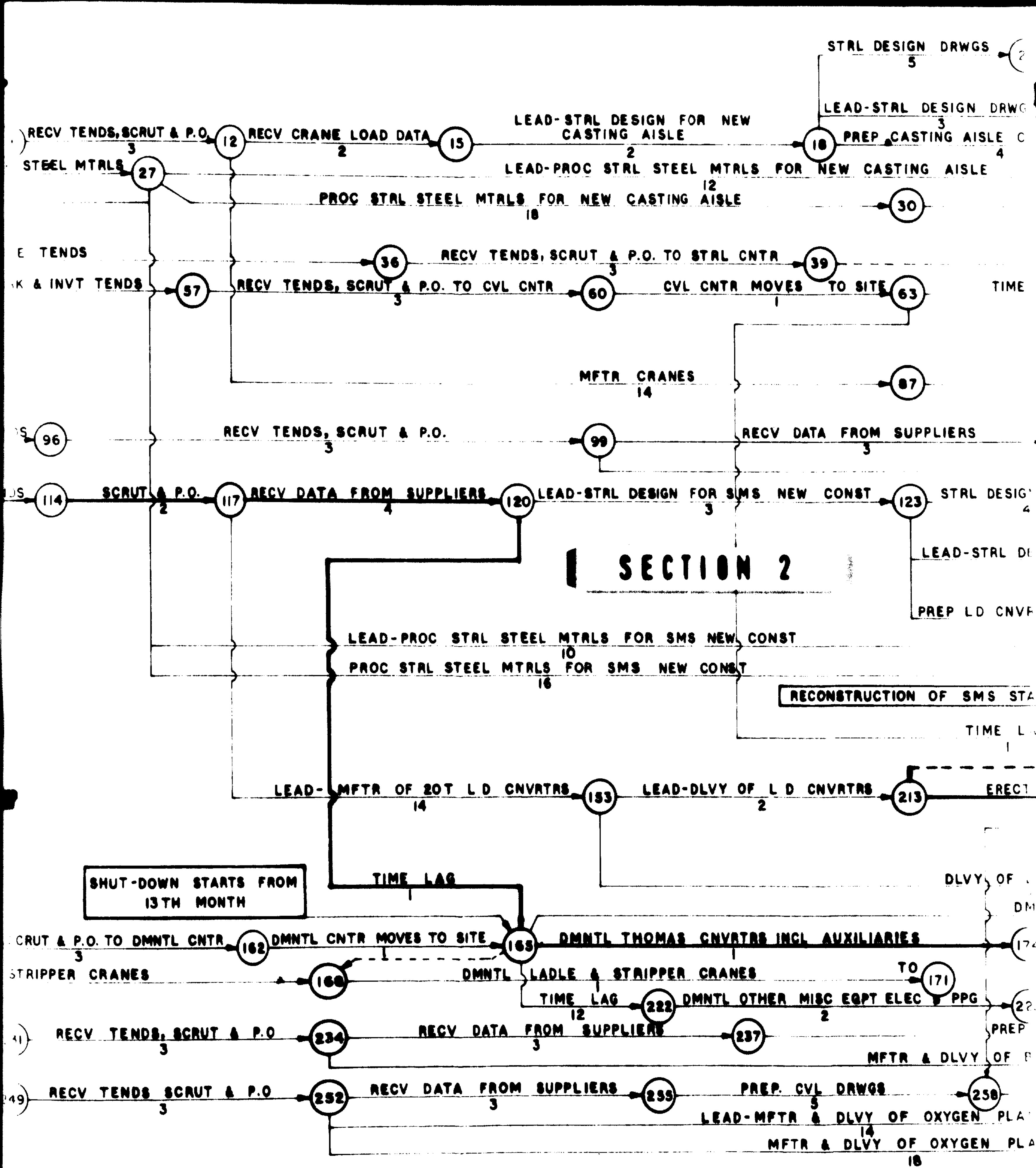
SPECS FOR 20T LD CNVRTRS & INVT TENDS
3
RECV TENDS
2
SCRUT & P.O.
2
RECV DATA
TIME LAG
4
SPECS FOR NEW CASTING CRANES & INVT TENDS
2
RECV TENDS, SCRUT & P.O.
3
RECV CRAN
PREP PREL SMS LAYOUT
2
PREP BULK INDENT FOR STRL STEEL MTRLS
4
TIME LAG
3
PREP SPECS FOR STRL STEELWORK & INVITE TENDS
3
TIME LAG
1
PREP SPECS FOR CVL WORK & INVT TENDS
3
RECV TENDS,
TIME LAG
13
SPECS FOR CASTING AISLE MISC EQPT & INVT TENDS
3
RECV TENDS,
SECTION 1
LEAD-
SHUT-DOWN STARTS FROM 13TH MONTH
TIME LAG
4
SPECS FOR DMNTL WORK & INVT TENDS
3
RECV TENDS, SCRUT & P.O. TO DMNTL CNTR
3
DMNTL
TIME LAG BEFORE DMNTL OF LADLE & STRIPPER CRANES
32
TIME LAG
13
SPECS FOR BLCE SMS EQPT & INVT TENDS
3
RECV TENDS, SCRUT & P.O
3
TIME LAG
6
SPECS FOR OXYGEN PLANT & INVT TENDS
3
RECV TENDS SCRUT & P.O
3


SECTION 2
STRL DESIGN DRWGS
5
LEAD-STRL DESIGN DRWG
3
RECV TENDS, SCRUT & P.O.
3
12
RECV CRANE LOAD DATA
2
15
LEAD-STRL DESIGN FOR NEW CASTING AISLE
2
18
PREP CASTING AISLE C
4
STEEL MTRLS
27
LEAD-PROC STRL STEEL MTRLS FOR NEW CASTING AISLE
12
PROC STRL STEEL MTRLS FOR NEW CASTING AISLE
18
30
E TENDS
36
RECV TENDS, SCRUT & P.O. TO STRL CNTR
3
39
K & INVT TENDS
57
RECV TENDS, SCRUT & P.O. TO CVL CNTR
3
60
CVL CNTR MOVES TO SITE
1
63
TIME
MFTR CRANES
14
87
96
RECV TENDS, SCRUT & P.O.
3
99
RECV DATA FROM SUPPLIERS
3
114
SCRUT & P.O.
2
117
RECV DATA FROM SUPPLIERS
4
120
LEAD-STRL DESIGN FOR SMS NEW CONST
3
123
STRL DESIG
4
LEAD-STRL DE
PREP LD CNVR
LEAD-PROC STRL STEEL MTRLS FOR SMS NEW CONST
10
PROC STRL STEEL MTRLS FOR SMS NEW CONST
16
RECONSTRUCTION OF SMS STA
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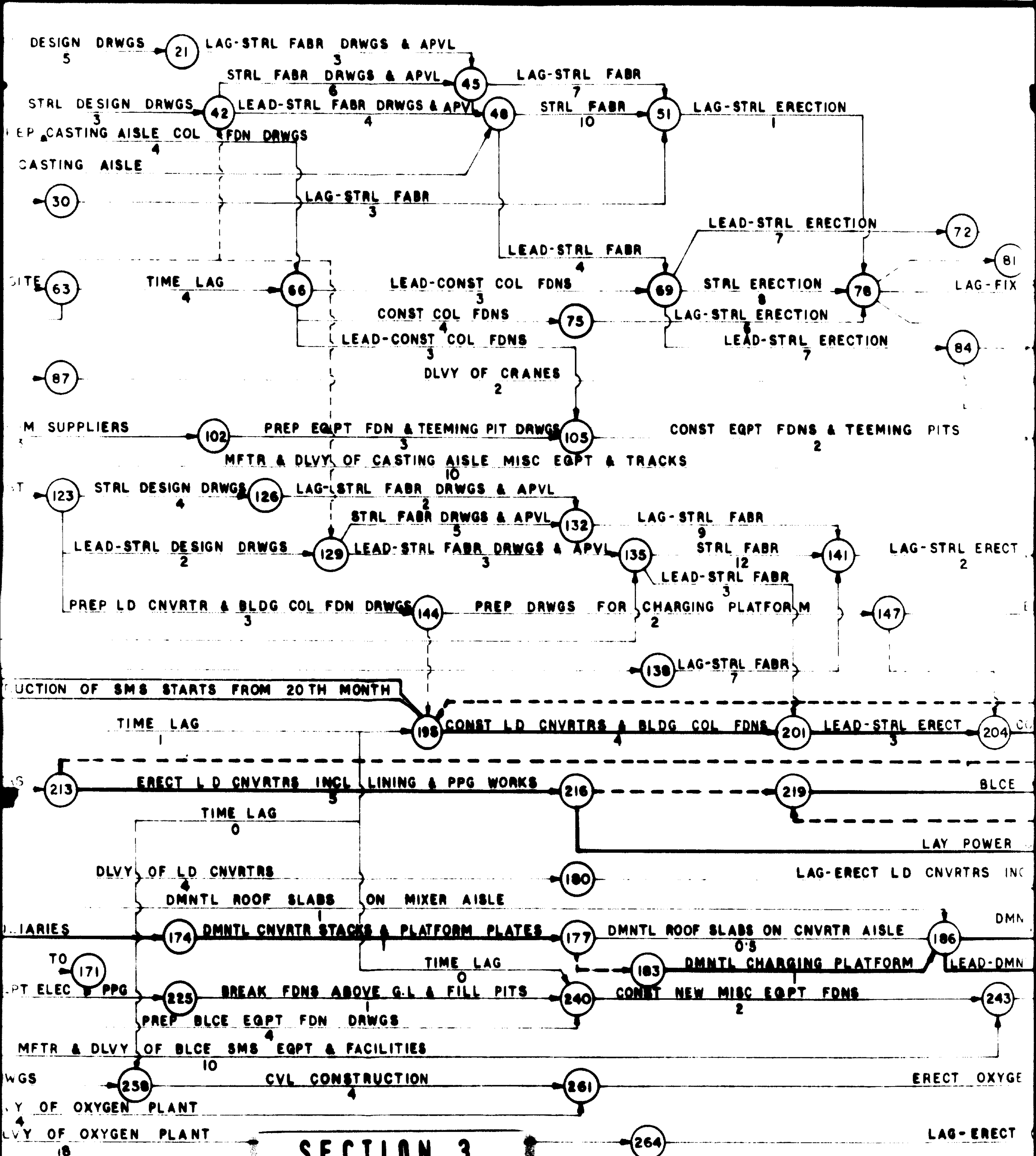
1
LEAD-MFTR OF 20T L D CNVRTRS
14
153
LEAD-DLVY OF L D CNVRTRS
2
213
ERECT
SHUT-DOWN STARTS FROM 13TH MONTH
TIME LAG
1
DLVY OF
DM
CRUT & P.O. TO DMNTL CNTR
3
162
DMNTL CNTR MOVES TO SITE
1
165
DMNTL THOMAS CNVRTRS INCL AUXILIARIES
1
174
STRIPPER CRANES
168
DMNTL LADLE & STRIPPER CRANES
1
TO
171
TIME LAG
12
222
DMNTL OTHER MISC EQPT ELEC & PPG
2
RECV TENDS, SCRUT & P.O
3
234
RECV DATA FROM SUPPLIERS
3
237
PREP
MFTR & DLVY OF
249
RECV TENDS SCRUT & P.O
3
252
RECV DATA FROM SUPPLIERS
3
255
PREP. CVL DRWGS
5
258
LEAD-MFTR & DLVY OF OXYGEN PLA
14
MFTR & DLVY OF OXYGEN PLA
18


DESIGN DRWGS 5
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LAG-STRL FABR DRWGS & APVL 3
STRL FABR DRWGS & APVL 6
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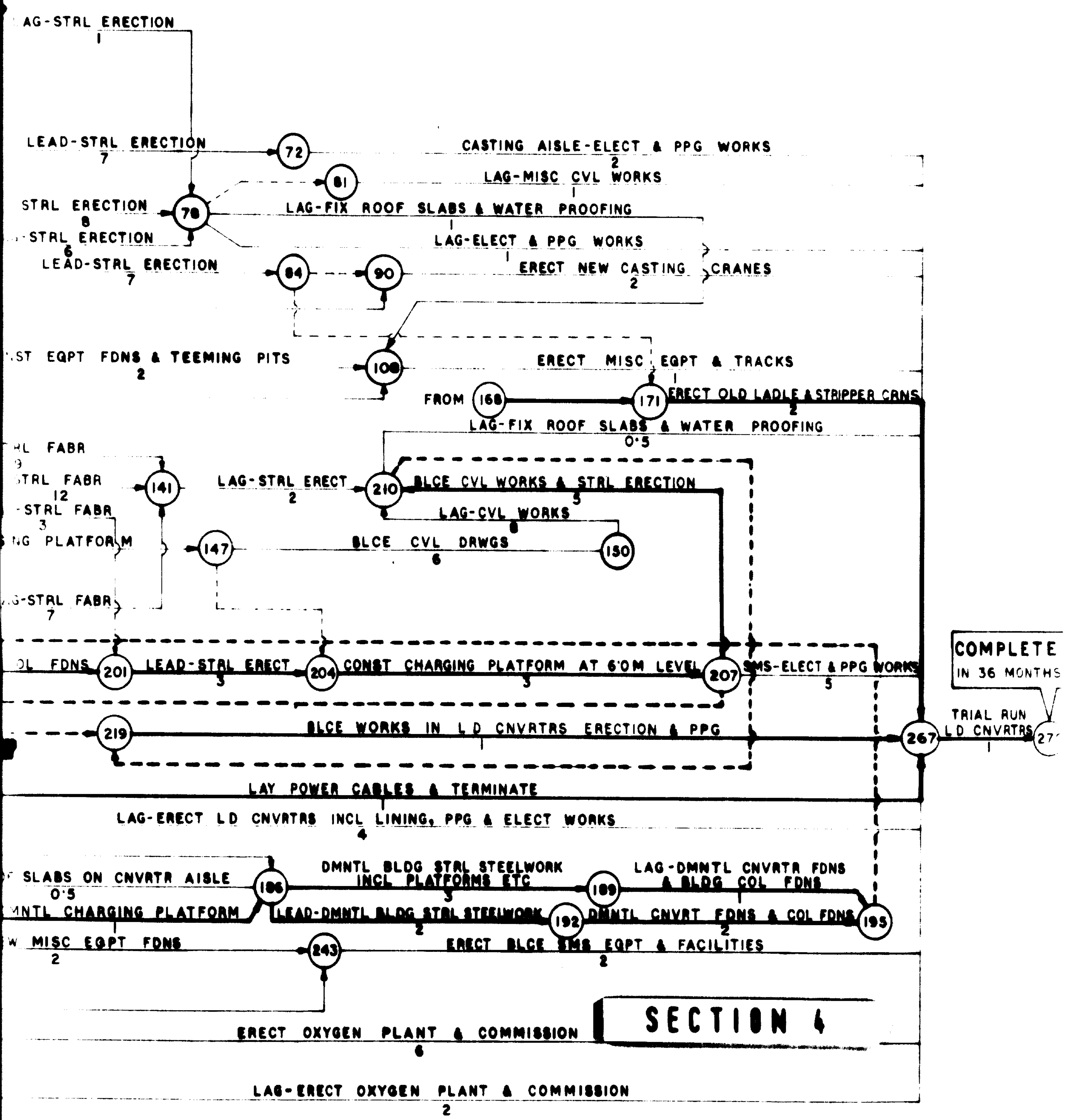
LAG-STRL FABR 7
STRL DESIGN DRWGS 3
42
LEAD-STRL FABR DRWGS & APVL 4
48
STRL FABR 10
51
LAG-STRL ERECTION 1
EP CASTING AISLE COL FDN DRWGS 4
CASTING AISLE
30
LAG-STRL FABR 3
LEAD-STRL ERECTION 7
72
LEAD-STRL FABR 4
81
63
TIME LAG 4
66
LEAD-CONST COL FDNS 3
69
STRL ERECTION 8
78
LAG-FIX
CONST COL FDNS 4
75
LAG-STRL ERECTION 6
LEAD-CONST COL FDNS 3
LEAD-STRL ERECTION 7
84
87
DLVY OF CRANES 2
M SUPPLIERS
102
PREP EQPT FDN & TEEMING PIT DRWGS 3
105
CONST EQPT FDNS & TEEMING PITS 2
MFTR & DLVY OF CASTING AISLE MISC EQPT & TRACKS 10
123
STRL DESIGN DRWGS 4
126
LAG-STRL FABR DRWGS & APVL 2
STRL FABR DRWGS & APVL 5
132
LAG-STRL FABR 9
LEAD-STRL DESIGN DRWGS 2
129
LEAD-STRL FABR DRWGS & APVL 3
135
STRL FABR 12
141
LAG-STRL ERECT 2
LEAD-STRL FABR 3
PREP LD CNVRTR & BLDG COL FDN DRWGS 3
144
PREP DRWGS FOR CHARGING PLATFORM 2
147
138
LAG-STRL FABR 7
UCTION OF SMS STARTS FROM 20TH MONTH
TIME LAG 1
198
CONST LD CNVRTRS & BLDG COL FDNS 4
201
LEAD-STRL ERECT 3
204
213
ERECT L D CNVRTRS INCL LINING & PPG WORKS 5
216
219
BLCE
TIME LAG 0
LAY POWER
DLVY OF LD CNVRTRS 4
180
LAG-ERECT LD CNVRTRS INC
DMNTL ROOF SLABS ON MIXER AISLE 1
IARIES
174
DMNTL CNVRTR STACKS & PLATFORM PLATES 1
177
DMNTL ROOF SLABS ON CNVRTR AISLE 0.5
186
DMN
TO
171
TIME LAG 0
183
DMNTL CHARGING PLATFORM 1
LEAD-DMN
PT ELEC & PPG
225
BREAK FDNS ABOVE G.L & FILL PITS 1
240
CONST NEW MISC EQPT FDNS 2
243
PREP BLCE EQPT FDN DRWGS 4
MFTR & DLVY OF BLCE SMS EQPT & FACILITIES 10
WGS
258
CVL CONSTRUCTION 4
261
ERECT OXYGE
Y OF OXYGEN PLANT 4
LVY OF OXYGEN PLANT 18
264
LAG-ERECT

SECTION 3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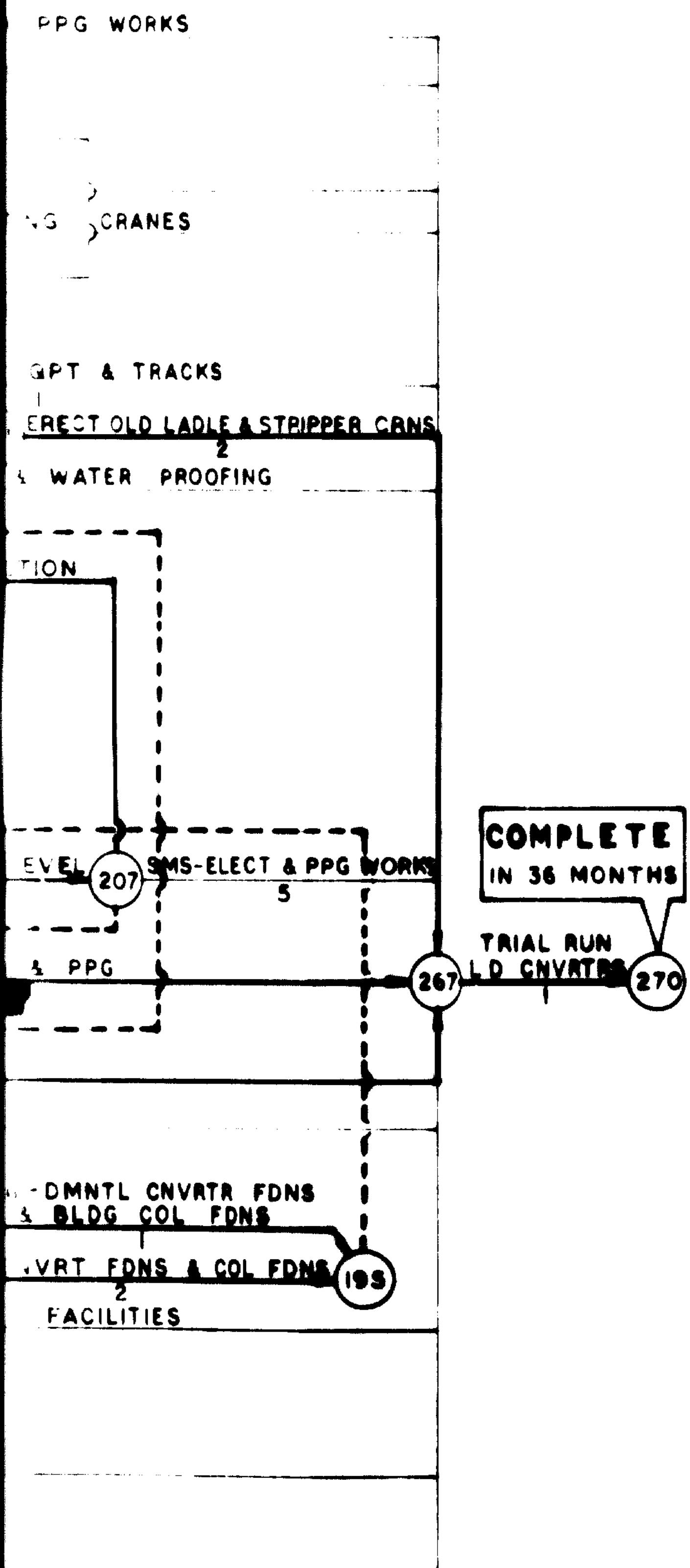
LEAD-STRL ERECTION
7
72
CASTING AISLE-ELECT & PPG WORKS
2
81
LAG-MISC CVL WORKS
1
STRL ERECTION
8
78
LAG-FIX ROOF SLABS & WATER PROOFING
1
-STRL ERECTION
6
LAG-ELECT & PPG WORKS
1
LEAD-STRL ERECTION
7
84
90
ERECT NEW CASTING CRANES
2
ST EQPT FDNS & TEEMING PITS
2
108
ERECT MISC EQPT & TRACKS
1
FROM
168
171
ERECT OLD LADLE & STRIPPER CRNS
2
LAG-FIX ROOF SLABS & WATER PROOFING
0·5
RL FABR
9
STRL FABR
12
141
LAG-STRL ERECT
2
210
BLCE CVL WORKS & STRL ERECTION
5
-STRL FABR
3
LAG-CVL WORKS
8
NG PLATFORM
147
BLCE CVL DRWGS
6
150
G-STRL FABR
7
COMPLETE
IN 36 MONTHS
OL FDNS
201
LEAD-STRL ERECT
3
204
CONST CHARGING PLATFORM AT 6·0M LEVEL
3
207
SMS-ELECT & PPG WORKS
5
219
BLCE WORKS IN L D CNVRTRS ERECTION & PPG
1
267
TRIAL RUN
L D CNVRTRS
1
LAY POWER CABLES & TERMINATE
1
LAG-ERECT LD CNVRTRS INCL LINING, PPG & ELECT WORKS
4
SLABS ON CNVRTR AISLE
0·5
186
DMNTL BLDG STRL STEELWORK
INCL PLATFORMS ETC
3
189
LAG-DMNTL CNVRTR FDNS
& BLDG COL FDNS
1
MNTL CHARGING PLATFORM
1
LEAD-DMNTL BLDG STRL STEELWORK
2
192
DMNTL CNVRT FDNS & COL FDNS
2
195
W MISC EQPT FDNS
2
243
ERECT BLCE SMS EQPT & FACILITIES
2
SECTION 4
ERECT OXYGEN PLANT & COMMISSION
6
LAG-ERECT OXYGEN PLANT & COMMISSION
2



NOTES:

1. ACTIVITY DURATIONS IN MONTHS.
2. CRITICAL PATH SHOWN IN RED.
3. FOLLOWING ABBREVIATIONS HAVE BEEN USED IN ACTIVITY DESCRIPTIONS:

APVL	=	APPROVAL
AUX	=	AUXILIARY
BLCE	=	BALANCE
BLDG	=	BUILDING
CNTR	=	CONTRACTOR
CNVRT	=	CONVERTER
COL	=	COLUMN
CONST	=	CONSTRUCT
CRN	=	CRANE
CVL	=	CIVIL
DLVY	=	DELIVERY
DMNTL	=	DISMANTLE
DRWG	=	DRAWING
ELECT	=	ELECTRICAL
EQPT	=	EQUIPMENT
FABR	=	FABRICATE / FABRICATION
FDN	=	FOUNDATION
G.L	=	GROUND LEVEL
INCL	=	INCLUDING
INVT	=	INVITE
MFTR	=	MANUFACTURE
MISC	=	MISCELLANEOUS
MTRL	=	MATERIAL
P.O.	=	PLACE ORDER
PPG	=	PIPING
PREL	=	PRELIMINARY
PREP	=	PREPARE
PROC	=	PROCURE
RECV	=	RECEIVE
SCRUT	=	SCRUTINISE
SPECS	=	SPECIFICATIONS
STRL	=	STRUCTURAL
TEND	=	TENDER

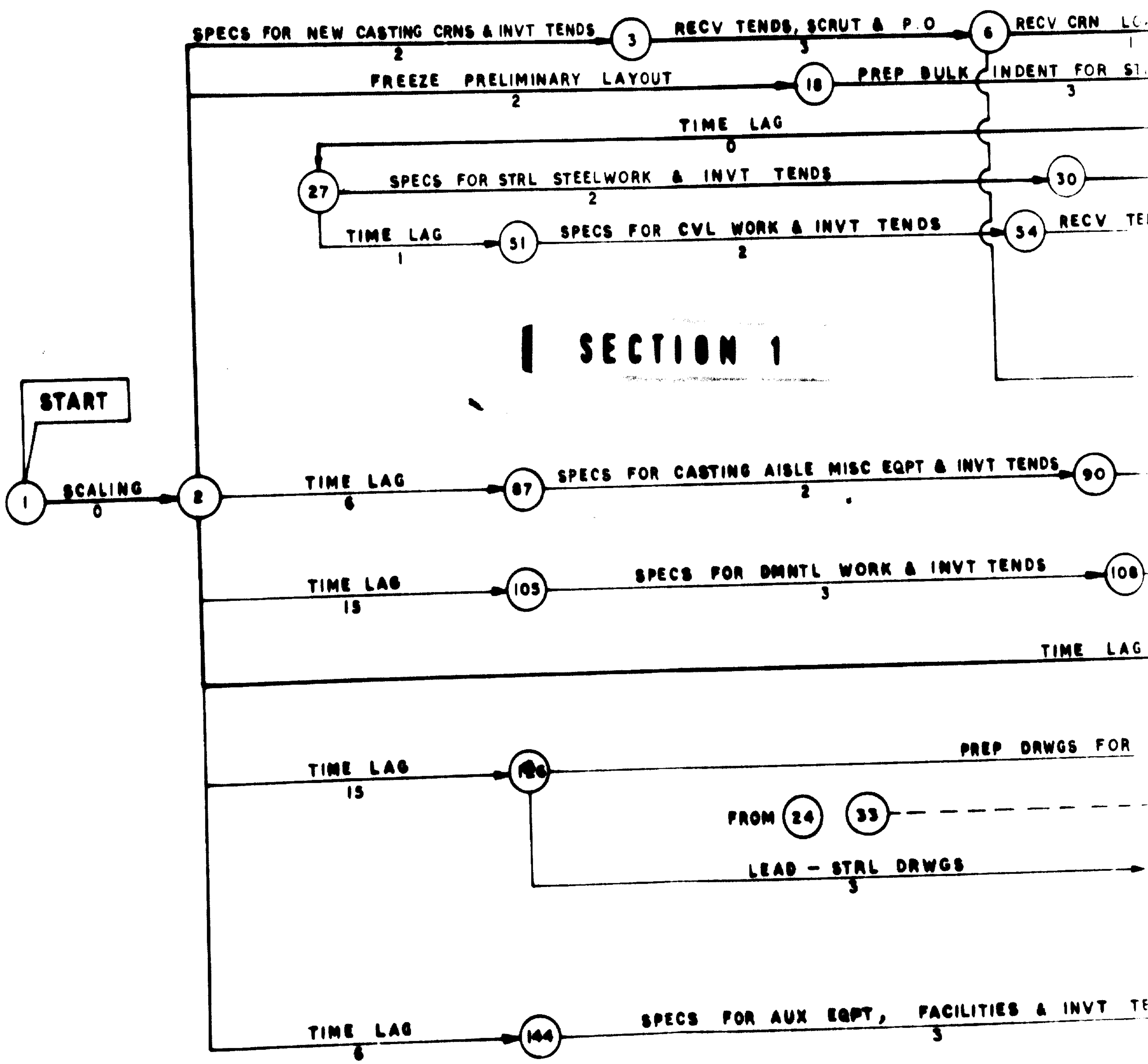
SECTION 5

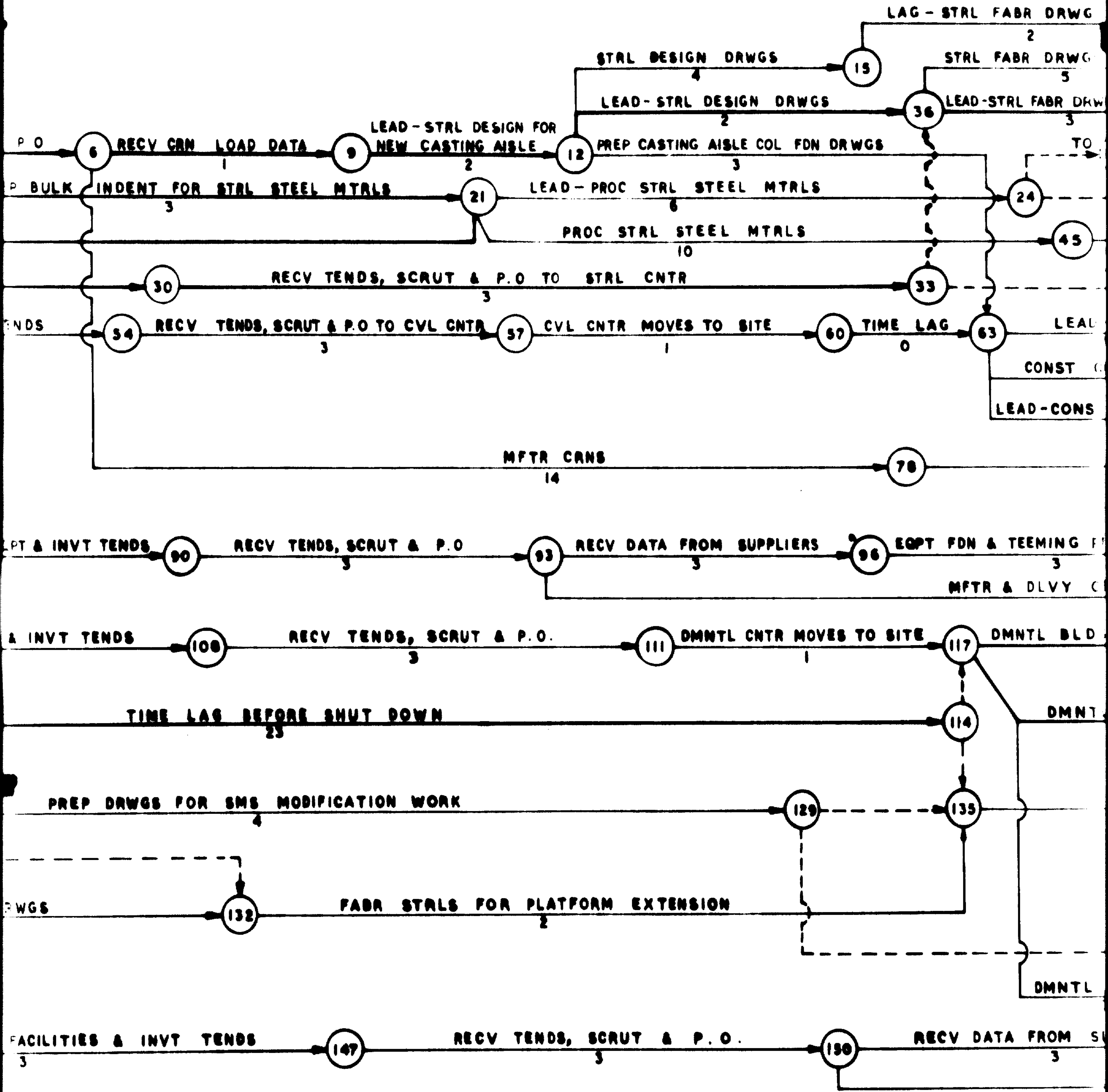
DASTUR ENGINEERING INTERNATIONAL GmbH
CONSULTING ENGINEERS, DÜSSELDORF

FOR:
UNITED NATIONS
INDUSTRIAL DEVELOPMENT ORGANIZATION

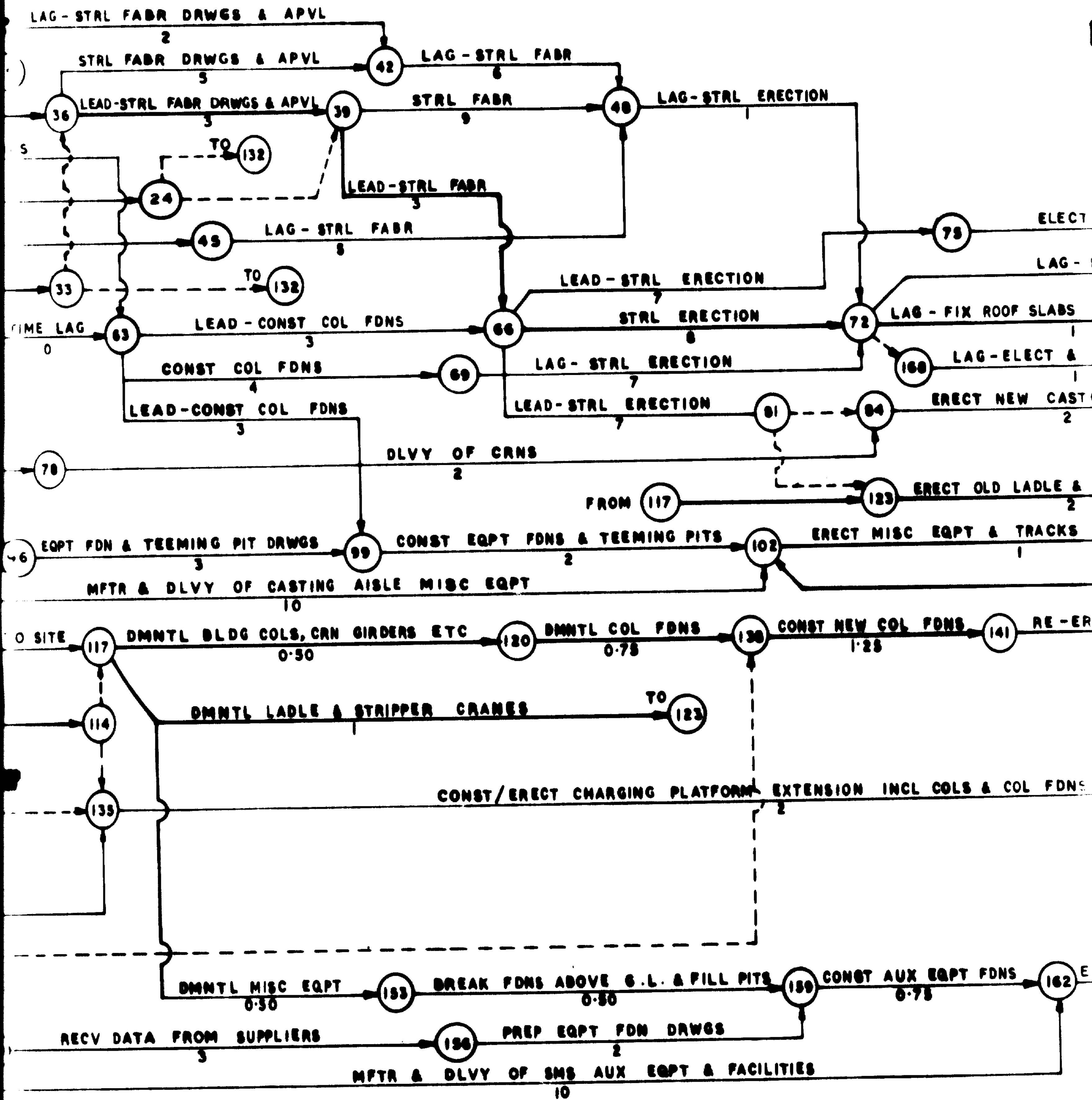
HELWAN IRON & STEEL PLANT
CRITICAL PATH NETWORK—ALT. I MODIFICATION

DRAWN	[signature]	2.6.72	No. 519-6-1
APPROVED	[signature]	5.6.72	

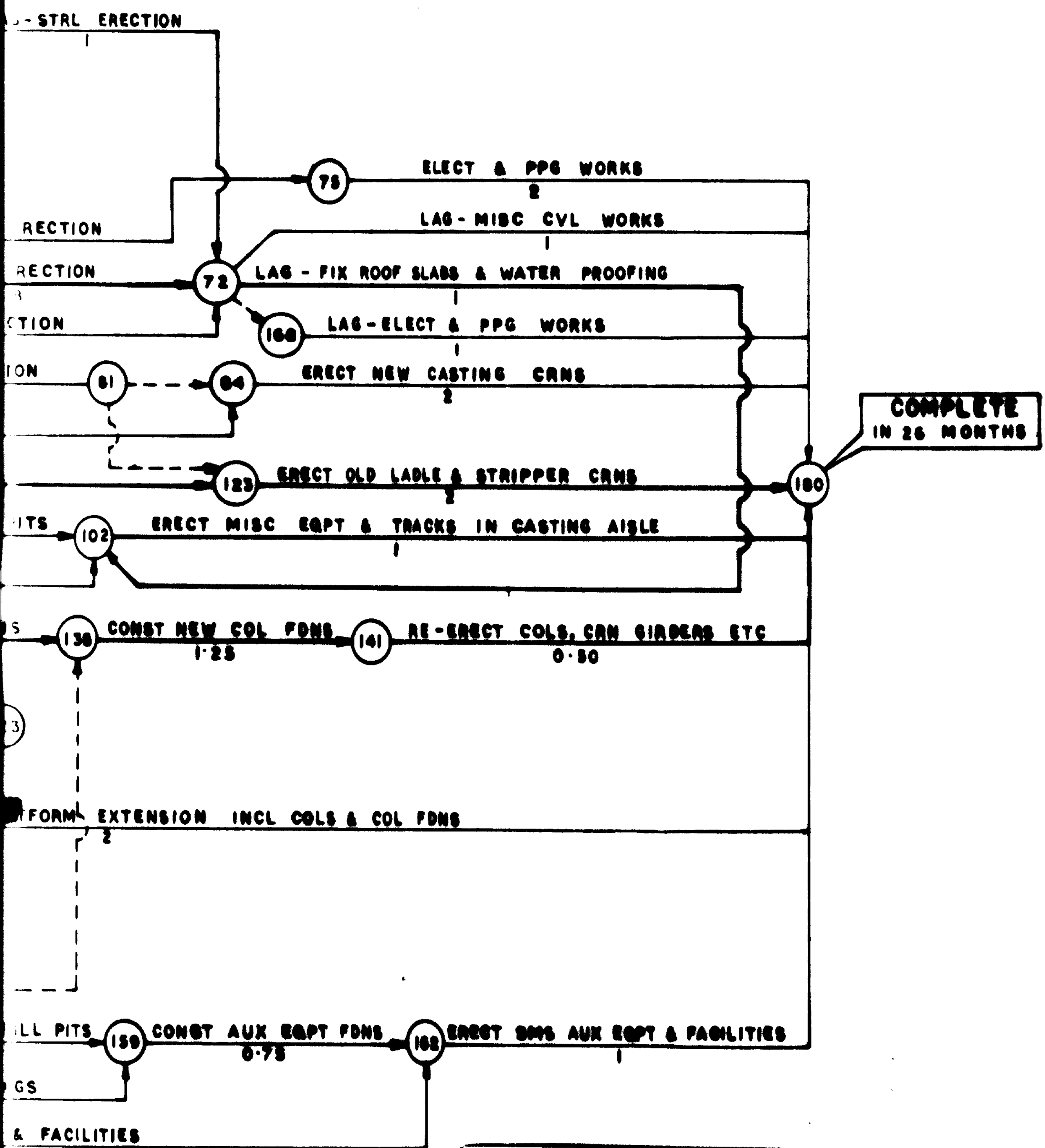

SECTION 1
START
SCALING
0
SPECS FOR NEW CASTING CRNS & INVT TENDS
2
RECV TENDS, SCRUT & P.O
3
RECV CRN
1
FREEZE PRELIMINARY LAYOUT
2
PREP BULK INDENT FOR
3
TIME LAG
0
SPECS FOR STRL STEELWORK & INVT TENDS
2
TIME LAG
1
SPECS FOR CVL WORK & INVT TENDS
2
RECV
TIME LAG
6
SPECS FOR CASTING AISLE MISC EQPT & INVT TENDS
2
TIME LAG
15
SPECS FOR DMNTL WORK & INVT TENDS
3
TIME LAG
TIME LAG
15
PREP DRWGS FOR
FROM 24 33
LEAD - STRL DRWGS
3
TIME LAG
6
SPECS FOR AUX EQPT, FACILITIES & INVT
3


LAG - STRL FABR DRWG
2
STRL DESIGN DRWGS
4
15
STRL FABR DRWG
5
LEAD - STRL DESIGN DRWGS
2
36
LEAD-STRL FABR DRW
3
P O
6
RECV CRN LOAD DATA
1
9
LEAD - STRL DESIGN FOR NEW CASTING AISLE
2
12
PREP CASTING AISLE COL FDN DRWGS
3
TO
P BULK
INDENT FOR STRL STEEL MTRLS
3
21
LEAD - PROC STRL STEEL MTRLS
6
24
PROC STRL STEEL MTRLS
10
45
30
RECV TENDS, SCRUT & P.O TO STRL CNTR
3
33
NDS
54
RECV TENDS, SCRUT & P.O TO CVL CNTR
3
57
CVL CNTR MOVES TO SITE
1
60
TIME LAG
0
63
LEAD
CONST
LEAD-CONS
MFTR CRNS
14
78
PT & INVT TENDS
90
RECV TENDS, SCRUT & P.O
3
93
RECV DATA FROM SUPPLIERS
3
96
EQPT FDN & TEEMING
3
MFTR & DLVY
& INVT TENDS
108
RECV TENDS, SCRUT & P.O.
3
111
DMNTL CNTR MOVES TO SITE
1
117
DMNTL BLD
TIME LAG BEFORE SHUT DOWN
23
114
DMNT
PREP DRWGS FOR SMS MODIFICATION WORK
4
129
135
WGS
132
FABR STRLS FOR PLATFORM EXTENSION
2
DMNTL
FACILITIES & INVT TENDS
3
147
RECV TENDS, SCRUT & P.O.
3
150
RECV DATA FROM S
3

SECTION 2


LAG - STRL FABR DRWGS & APVL
2
STRL FABR DRWGS & APVL
5
42
LAG - STRL FABR
6
36
LEAD-STRL FABR DRWGS & APVL
3
39
STRL FABR
9
48
LAG - STRL ERECTION
1
TO 132
24
LEAD-STRL FABR
3
45
LAG - STRL FABR
5
75
ELECT
33
TO 132
LEAD - STRL ERECTION
7
LAG -
TIME LAG
0
63
LEAD - CONST COL FDNS
3
66
STRL ERECTION
6
72
LAG - FIX ROOF SLABS
1
CONST COL FDNS
4
69
LAG - STRL ERECTION
7
168
LAG - ELECT &
1
LEAD - CONST COL FDNS
3
LEAD - STRL ERECTION
7
81
84
ERECT NEW CAST
2
78
DLVY OF CRNS
2
FROM 117
123
ERECT OLD LADLE &
2
EQPT FDN & TEEMING PIT DRWGS
3
99
CONST EQPT FDNS & TEEMING PITS
2
102
ERECT MISC EQPT & TRACKS
1
MFTR & DLVY OF CASTING AISLE MISC EQPT
10
O SITE
117
DMNTL BLDG COLS, CRN GIRDERS ETC
0·50
120
DMNTL COL FDNS
0·75
138
CONST NEW COL FDNS
1·25
141
RE - ER
114
DMNTL LADLE & STRIPPER CRANES
1
TO 123
135
CONST/ERECT CHARGING PLATFORM EXTENSION INCL COLS & COL FDNS
2
DMNTL MISC EQPT
0·50
153
BREAK FDNS ABOVE G.L. & FILL PITS
0·50
159
CONST AUX EQPT FDNS
0·75
162
RECV DATA FROM SUPPLIERS
3
156
PREP EQPT FDN DRWGS
2
MFTR & DLVY OF SMS AUX EQPT & FACILITIES
10

SECTION 3



SECTION 4

NOTES:

1. ACTI
2. CRITI
3. FOLL
USED

APVL
AUX
BLDG
CNTR
COL
CONS
CRN
CVL
DLVY
DMNT
DRWG
ELEC
EQPT
FABR
FDN
G.L
INCL
INVT
MFTR
MISC
MTRL
P.O
PPG
PREP
PROC
RECV
SCRU
SMS
SPEC
STRL
TEND

DASTU

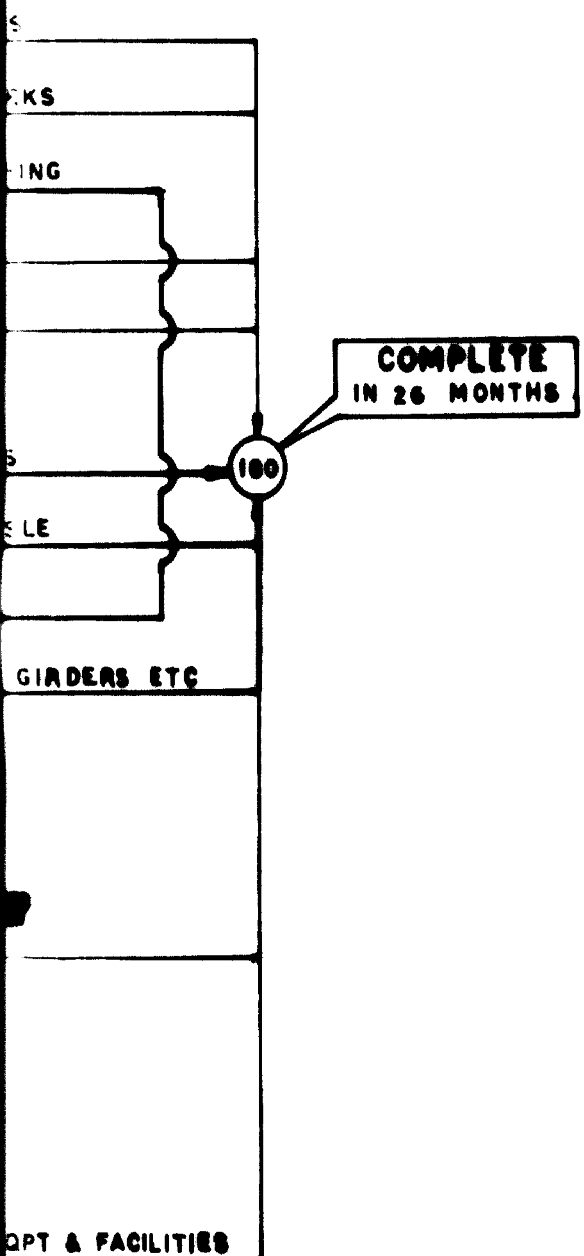
FOR:

INDU

CRI

DRAWN

APPROVED



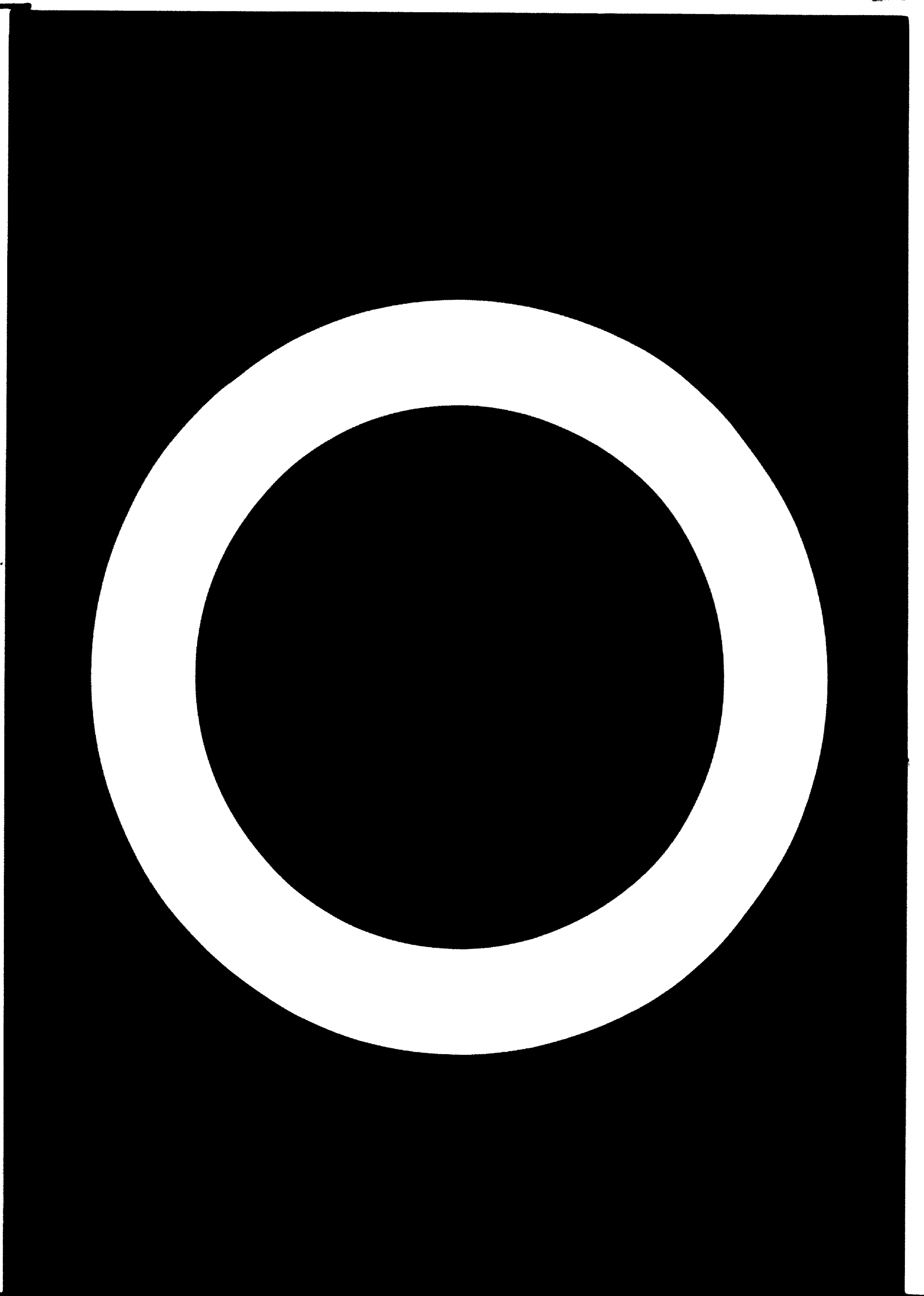
NOTES:

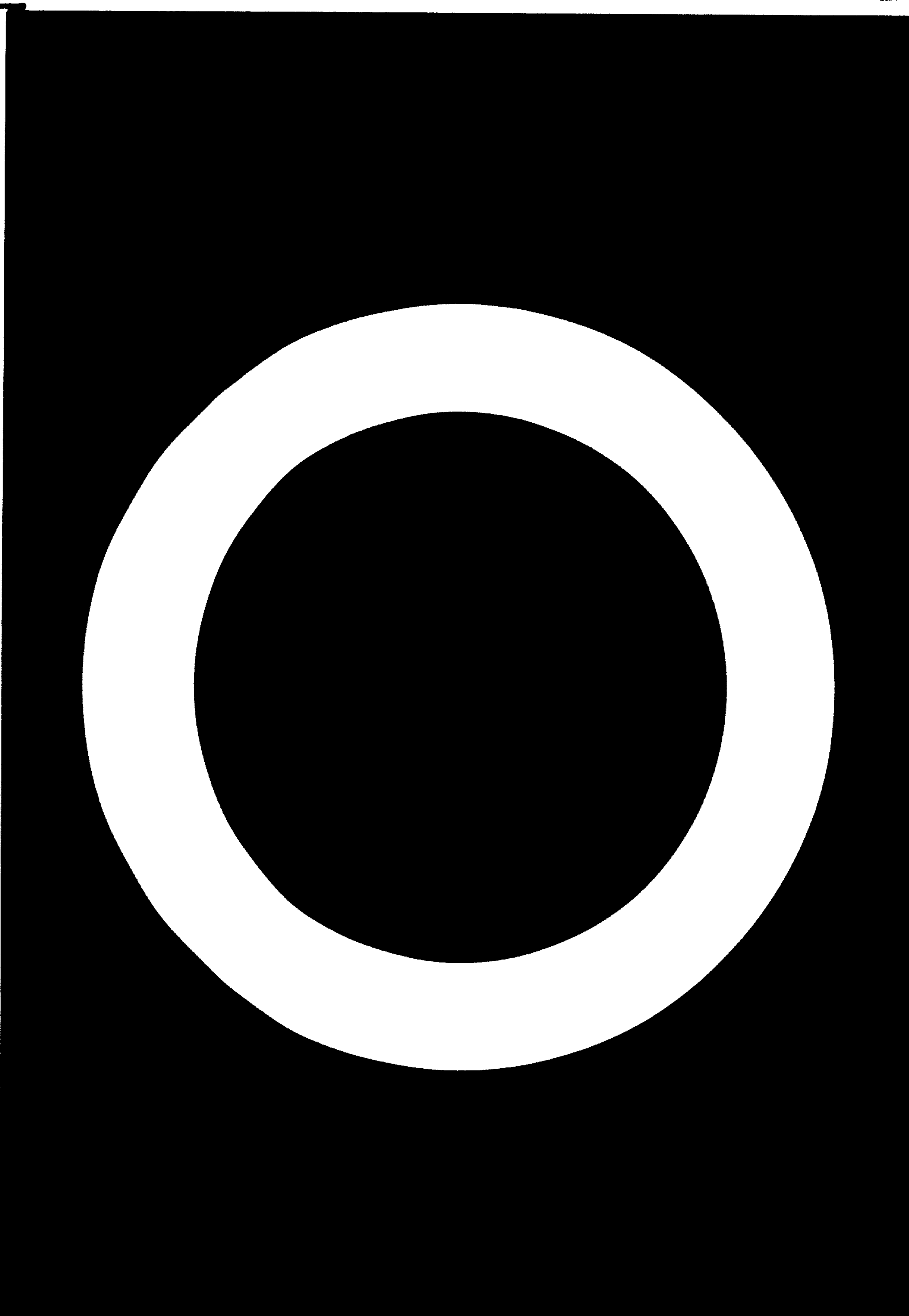
1. ACTIVITY DURATIONS IN MONTHS.
2. CRITICAL PATH SHOWN IN RED.
3. FOLLOWING ABBREVIATIONS HAVE BEEN USED IN ACTIVITY DESCRIPTIONS:

APVL = APPROVAL
AUX = AUXILIARY
BLDG = BUILDING
CNTR = CONTRACTOR
COL = COLUMN
CONST = CONSTRUCT
CRN = CRANE
CVL = CIVIL
DLVY = DELIVERY
DMNTL = DISMANTLE
DRWG = DRAWING
ELECT = ELECTRICAL
EQPT = EQUIPMENT
FABR = FABRICATION
FDN = FOUNDATION
G.L = GROUND LEVEL
INCL = INCLUDING
INVT = INVITE
MFTR = MANUFACTURE
MISC = MISCELLANEOUS
MTRL = MATERIAL
P.O = PLACE ORDER
PPG = PIPING
PREP = PREPARE
PROC = PROCURE
RECV = RECEIVE
SCRUT = SCRUTINISE
SMS = STEELMELT SHOP
SPECS = SPECIFICATIONS
STRL = STRUCTURAL
TEND = TENDER

SECTION 5

DASTUR ENGINEERING INTERNATIONAL GmbH CONSULTING ENGINEERS, DÜSSELDORF	
FOR: UNITED NATIONS INDUSTRIAL DEVELOPMENT ORGANIZATION	
HELWAN IRON & STEEL PLANT CRITICAL PATH NETWORK – ALT. 2 MODIFICATION	
DRAWN [signature] 14.6.72	No. 519-6-2
APPROVED [signature] 16.6.72	





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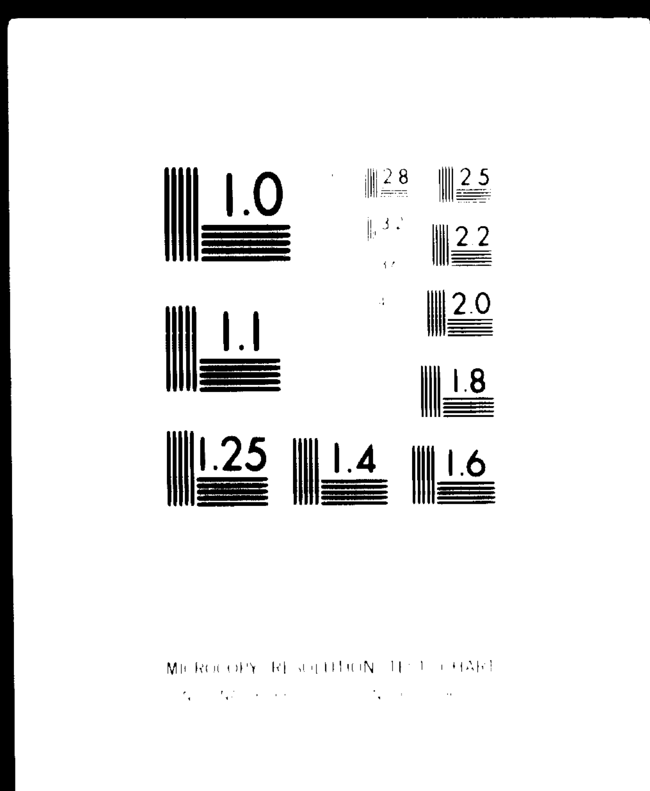

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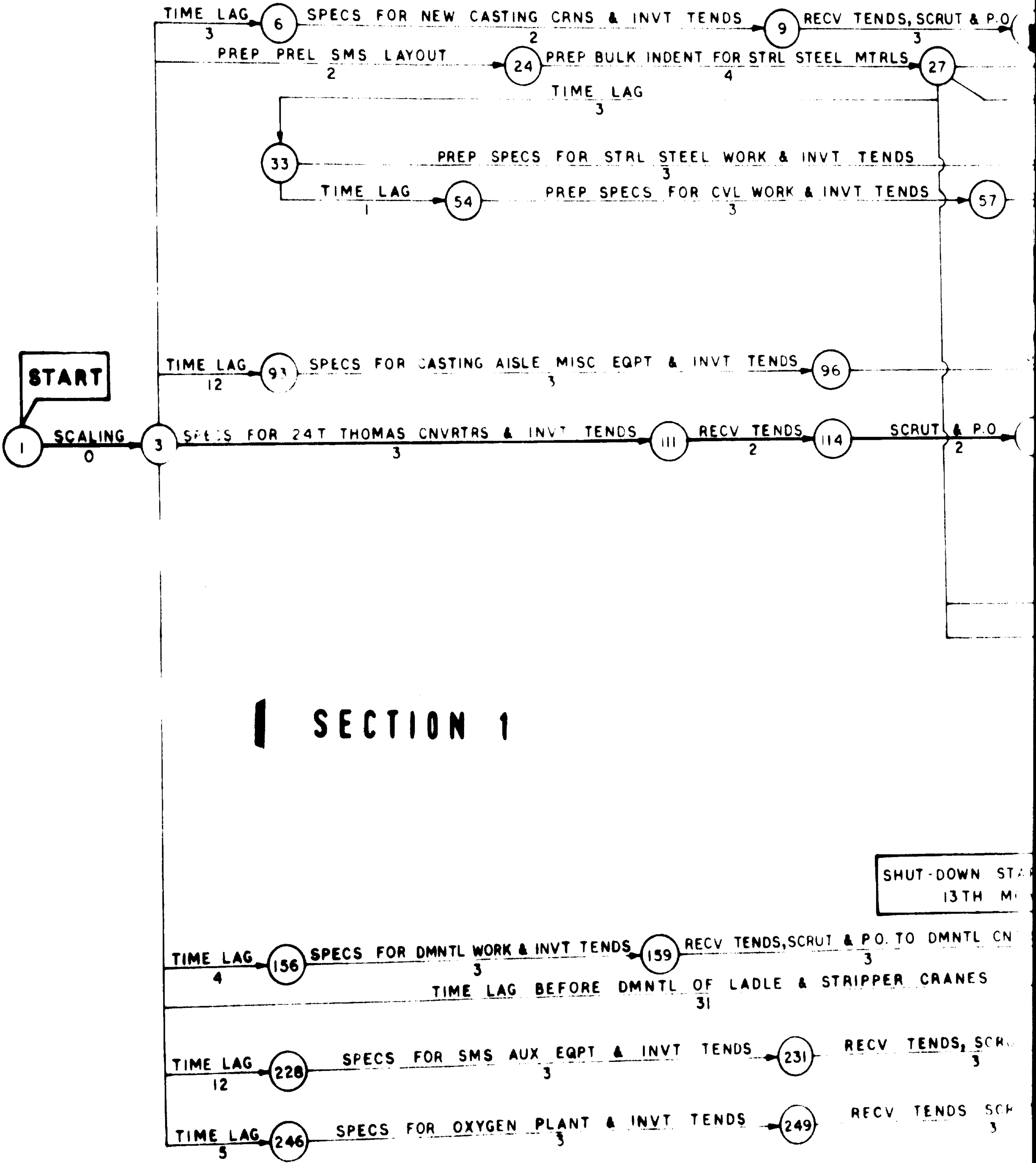
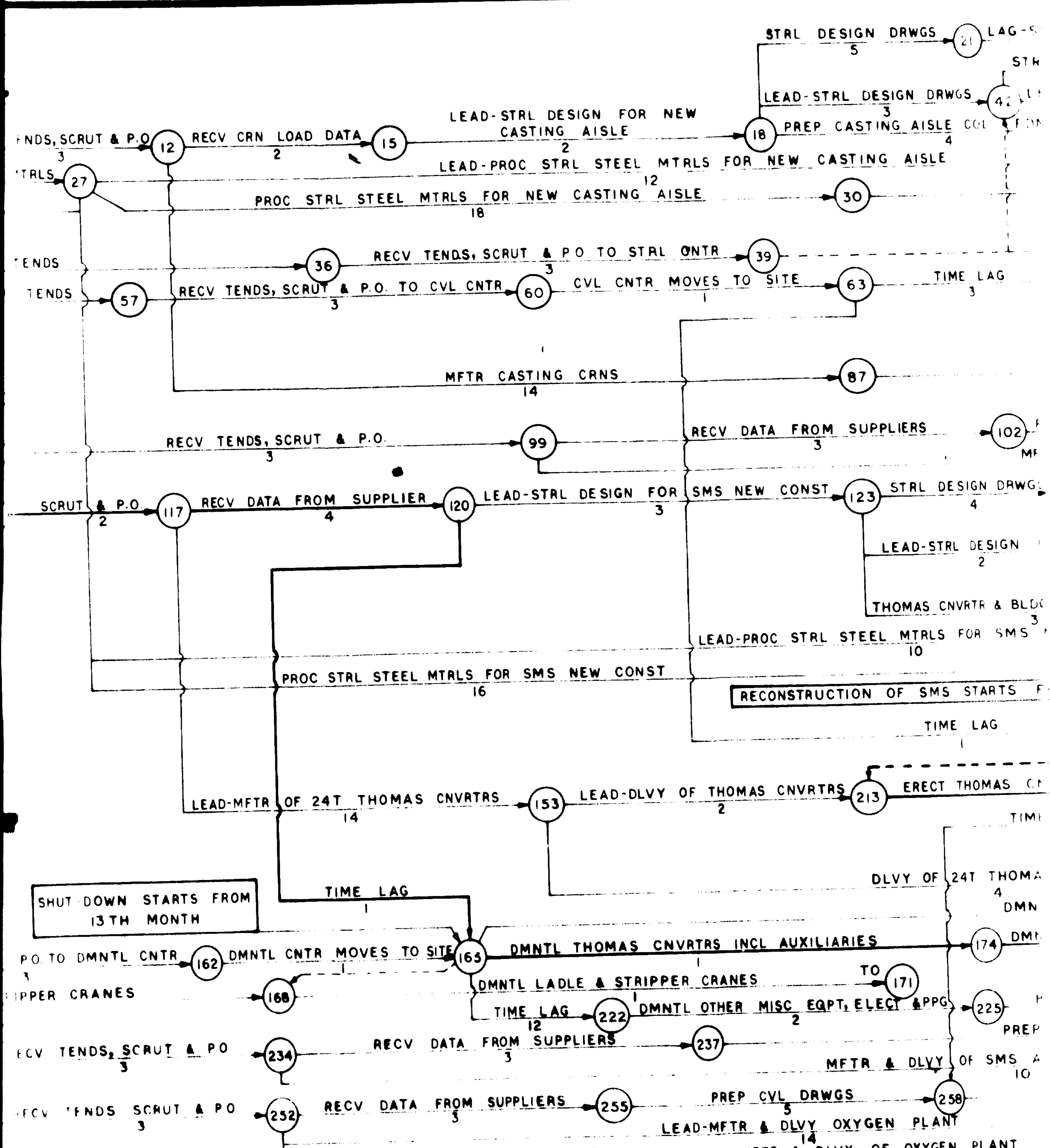


START
1
SCALING
0
3
TIME LAG
3
6
SPECS FOR NEW CASTING CRNS & INVT TENDS
2
9
RECV TENDS, SCRUT & P.O
3
PREP PREL SMS LAYOUT
2
24
PREP BULK INDENT FOR STRL STEEL MTRLS
4
27
TIME LAG
3
33
PREP SPECS FOR STRL STEEL WORK & INVT TENDS
3
TIME LAG
1
54
PREP SPECS FOR CVL WORK & INVT TENDS
3
57
TIME LAG
12
SPECS FOR CASTING AISLE MISC EQPT & INVT TENDS
3
96
SPECS FOR 24 T THOMAS CNVRTRS & INVT TENDS
3
111
RECV TENDS
2
114
SCRUT & P.O
2
SECTION 1
SHUT-DOWN
13TH
TIME LAG
4
156
SPECS FOR DMNTL WORK & INVT TENDS
3
159
RECV TENDS, SCRUT & P.O. TO DMNTL
3
TIME LAG BEFORE DMNTL OF LADLE & STRIPPER CRANES
31
TIME LAG
12
228
SPECS FOR SMS AUX EQPT & INVT TENDS
3
231
RECV TENDS,
3
TIME LAG
5
246
SPECS FOR OXYGEN PLANT & INVT TENDS
3
249
RECV TENDS
3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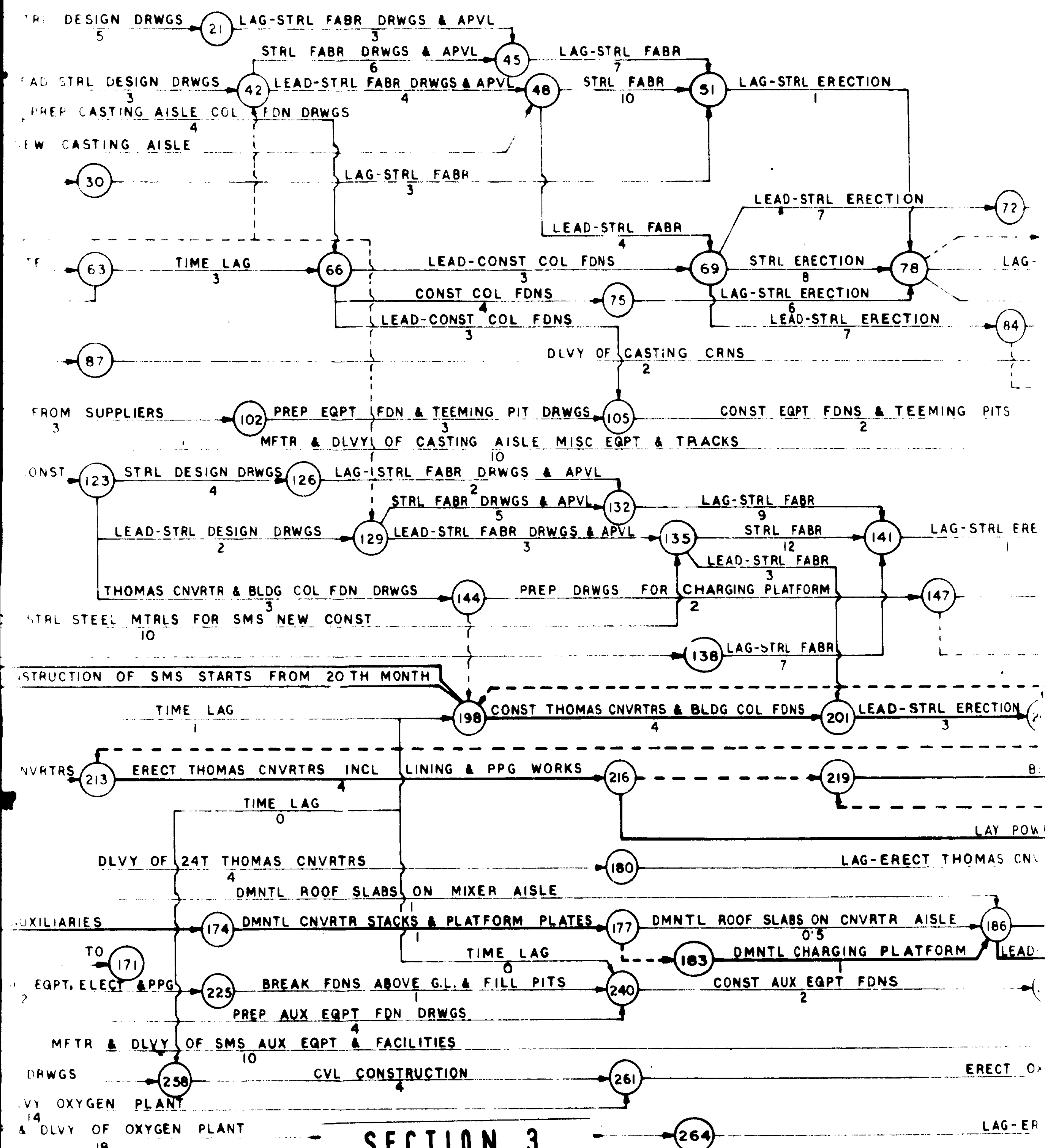
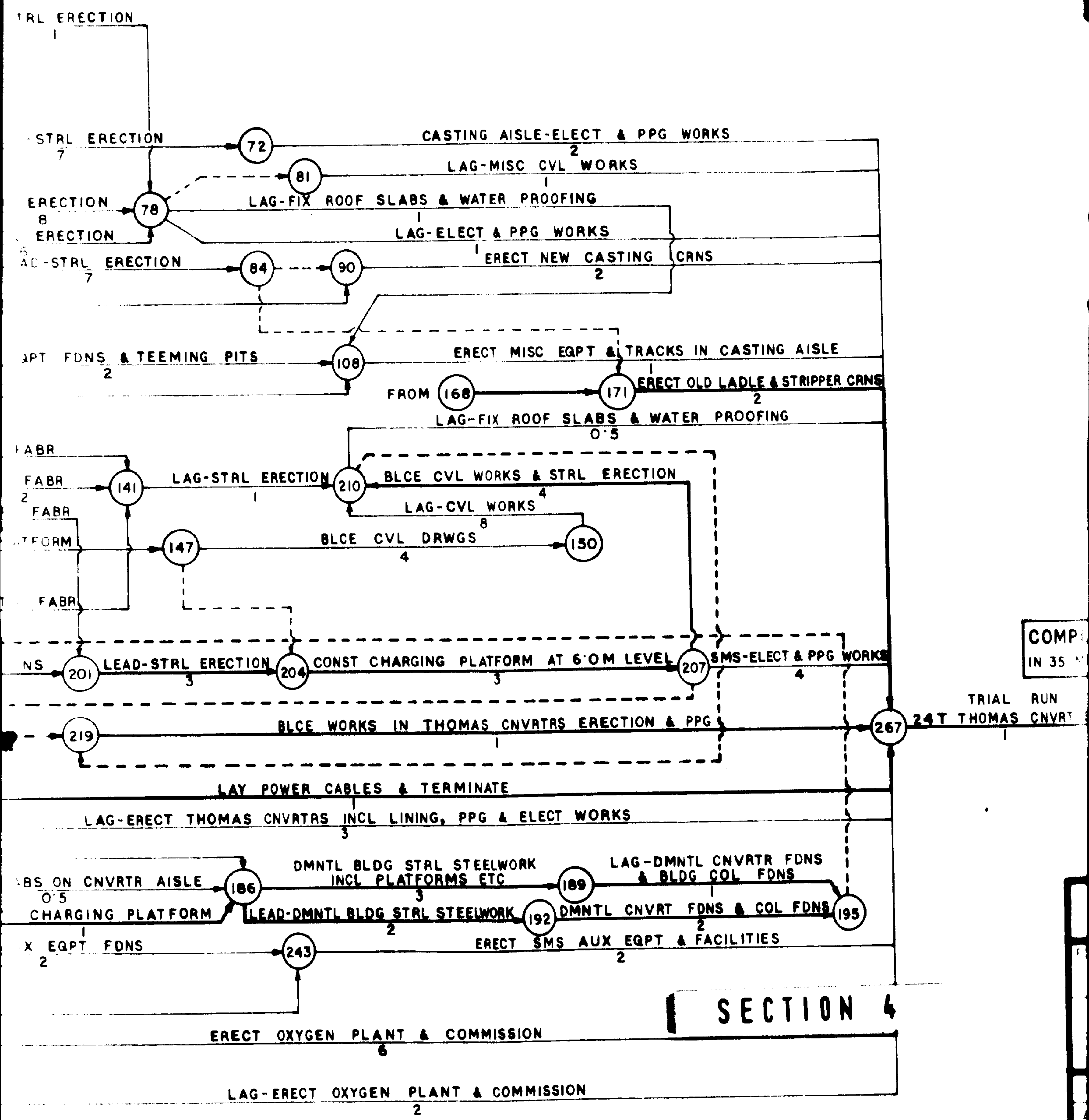
LEAD-STRL DESIGN DRWGS 3
LEAD-STRL DESIGN FOR NEW CASTING AISLE 2
PREP CASTING AISLE COL 4
TENDS, SCRUT & P.O 3
RECV CRN LOAD DATA 2
LEAD-PROC STRL STEEL MTRLS FOR NEW CASTING AISLE 12
PROC STRL STEEL MTRLS FOR NEW CASTING AISLE 18
RECV TENDS, SCRUT & P O TO STRL CNTR 3
RECV TENDS, SCRUT & P.O. TO CVL CNTR 3
CVL CNTR MOVES TO SITE 1
TIME LAG 3
MFTR CASTING CRNS 14
RECV TENDS, SCRUT & P.O. 3
RECV DATA FROM SUPPLIERS 3
SCRUT & P.O. 2
RECV DATA FROM SUPPLIER 4
LEAD-STRL DESIGN FOR SMS NEW CONST 3
STRL DESIGN DRWGS 4
LEAD-STRL DESIGN 2
THOMAS CNVRTR & BLDG 3
LEAD-PROC STRL STEEL MTRLS FOR SMS 10
PROC STRL STEEL MTRLS FOR SMS NEW CONST 16
RECONSTRUCTION OF SMS STARTS
TIME LAG 1
LEAD-MFTR OF 24T THOMAS CNVRTRS 14
LEAD-DLVY OF THOMAS CNVRTRS 2
ERECT THOMAS
DLVY OF 24T THOMAS 4
SHUT DOWN STARTS FROM 13TH MONTH
TIME LAG 1
P.O. TO DMNTL CNTR 3
DMNTL CNTR MOVES TO SITE 1
DMNTL THOMAS CNVRTRS INCL AUXILIARIES 1
DMNTL LADLE & STRIPPER CRANES 1
TO
TIME LAG 12
DMNTL OTHER MISC EQPT, ELECT & PPG 2
RECV TENDS, SCRUT & PO 3
RECV DATA FROM SUPPLIERS 3
MFTR & DLVY OF SMS 10
RECV TENDS SCRUT & PO 3
RECV DATA FROM SUPPLIERS 3
PREP CVL DRWGS 5
LEAD-MFTR & DLVY OXYGEN PLANT 14
MFTR & DLVY OF OXYGEN PLANT 18

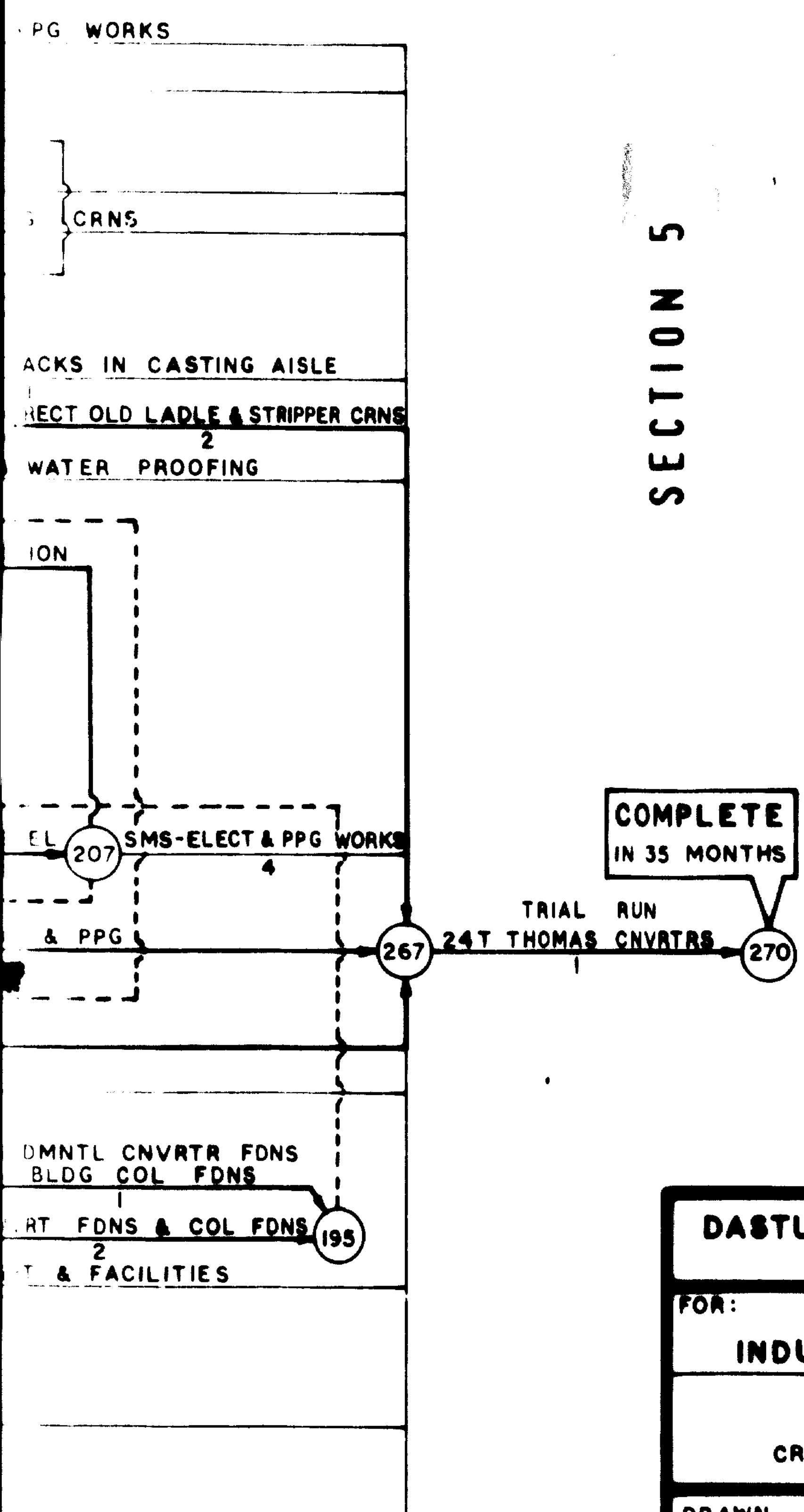
SECTION 2


DESIGN DRWGS
5
21
LAG-STRL FABR DRWGS & APVL
3
STRL FABR DRWGS & APVL
6
45
LAG-STRL FABR
7
STRL DESIGN DRWGS
3
42
LEAD-STRL FABR DRWGS & APVL
4
48
STRL FABR
10
51
LAG-STRL ERECTION
1
PREP CASTING AISLE COL FDN DRWGS
4
CASTING AISLE
30
LAG-STRL FABR
3
LEAD-STRL ERECTION
7
72
LEAD-STRL FABR
4
63
TIME LAG
3
66
LEAD-CONST COL FDNS
3
69
STRL ERECTION
8
78
LAG-
CONST COL FDNS
4
75
LAG-STRL ERECTION
6
LEAD-CONST COL FDNS
3
LEAD-STRL ERECTION
7
84
87
DLVY OF CASTING CRNS
2
FROM SUPPLIERS
3
102
PREP EQPT FDN & TEEMING PIT DRWGS
3
105
CONST EQPT FDNS & TEEMING PITS
2
MFTR & DLVY OF CASTING AISLE MISC EQPT & TRACKS
10
CONST
123
STRL DESIGN DRWGS
4
126
LAG-STRL FABR DRWGS & APVL
2
STRL FABR DRWGS & APVL
5
132
LAG-STRL FABR
9
LEAD-STRL DESIGN DRWGS
2
129
LEAD-STRL FABR DRWGS & APVL
3
135
STRL FABR
12
141
LAG-STRL ERE
1
LEAD-STRL FABR
3
THOMAS CNVRTR & BLDG COL FDN DRWGS
3
144
PREP DRWGS FOR CHARGING PLATFORM
2
147
STRL STEEL MTRLS FOR SMS NEW CONST
10
138
LAG-STRL FABR
7
STRUCTION OF SMS STARTS FROM 20TH MONTH
TIME LAG
1
198
CONST THOMAS CNVRTRS & BLDG COL FDNS
4
201
LEAD-STRL ERECTION
3
NVRTRS
213
ERECT THOMAS CNVRTRS INCL LINING & PPG WORKS
4
216
219
TIME LAG
0
LAY POW
DLVY OF 24T THOMAS CNVRTRS
4
180
LAG-ERECT THOMAS CN
DMNTL ROOF SLABS ON MIXER AISLE
1
UXILIARIES
174
DMNTL CNVRTR STACKS & PLATFORM PLATES
1
177
DMNTL ROOF SLABS ON CNVRTR AISLE
0·5
186
TO
171
TIME LAG
0
183
DMNTL CHARGING PLATFORM
1
LEAD
EQPT, ELECT & PPG
2
225
BREAK FDNS ABOVE G.L. & FILL PITS
1
240
CONST AUX EQPT FDNS
2
PREP AUX EQPT FDN DRWGS
4
MFTR & DLVY OF SMS AUX EQPT & FACILITIES
10
DRWGS
258
CVL CONSTRUCTION
4
261
ERECT O
VY OXYGEN PLANT
14
& DLVY OF OXYGEN PLANT
18
264
LAG-ER

SECTION 3



RL ERECTION
1
STRL ERECTION
7
ERECTION
8
ERECTION
AD-STRL ERECTION
7
72
CASTING AISLE-ELECT & PPG WORKS
2
81
LAG-MISC CVL WORKS
1
78
LAG-FIX ROOF SLABS & WATER PROOFING
1
LAG-ELECT & PPG WORKS
1
84
90
ERECT NEW CASTING CRNS
2
QPT FDNS & TEEMING PITS
2
108
ERECT MISC EQPT & TRACKS IN CASTING AISLE
1
FROM 168
171
ERECT OLD LADLE & STRIPPER CRNS
2
LAG-FIX ROOF SLABS & WATER PROOFING
0'5
FABR
FABR
2
FABR
TFORM
FABR
141
LAG-STRL ERECTION
1
210
BLCE CVL WORKS & STRL ERECTION
4
LAG-CVL WORKS
8
147
BLCE CVL DRWGS
4
150
NS
201
LEAD-STRL ERECTION
3
204
CONST CHARGING PLATFORM AT 6'0M LEVEL
3
207
SMS-ELECT & PPG WORKS
4
219
BLCE WORKS IN THOMAS CNVRTRS ERECTION & PPG
1
267
TRIAL RUN
24T THOMAS CNVRT
1
COMP
IN 35
LAY POWER CABLES & TERMINATE
1
LAG-ERECT THOMAS CNVRTRS INCL LINING, PPG & ELECT WORKS
3
BS ON CNVRTR AISLE
0'5
CHARGING PLATFORM
1
186
DMNTL BLDG STRL STEELWORK
INCL PLATFORMS ETC
3
189
LAG-DMNTL CNVRTR FDNS
& BLDG COL FDNS
1
LEAD-DMNTL BLDG STRL STEELWORK
2
192
DMNTL CNVRT FDNS & COL FDNS
2
195
X EQPT FDNS
2
243
ERECT SMS AUX EQPT & FACILITIES
2
SECTION 4
ERECT OXYGEN PLANT & COMMISSION
6
LAG-ERECT OXYGEN PLANT & COMMISSION
2



NOTES:

1. ACTIVITY DURATIONS IN MONTHS.
2. CRITICAL PATH SHOWN IN RED.
3. FOLLOWING ABBREVIATIONS HAVE BEEN USED IN ACTIVITY DESCRIPTIONS:

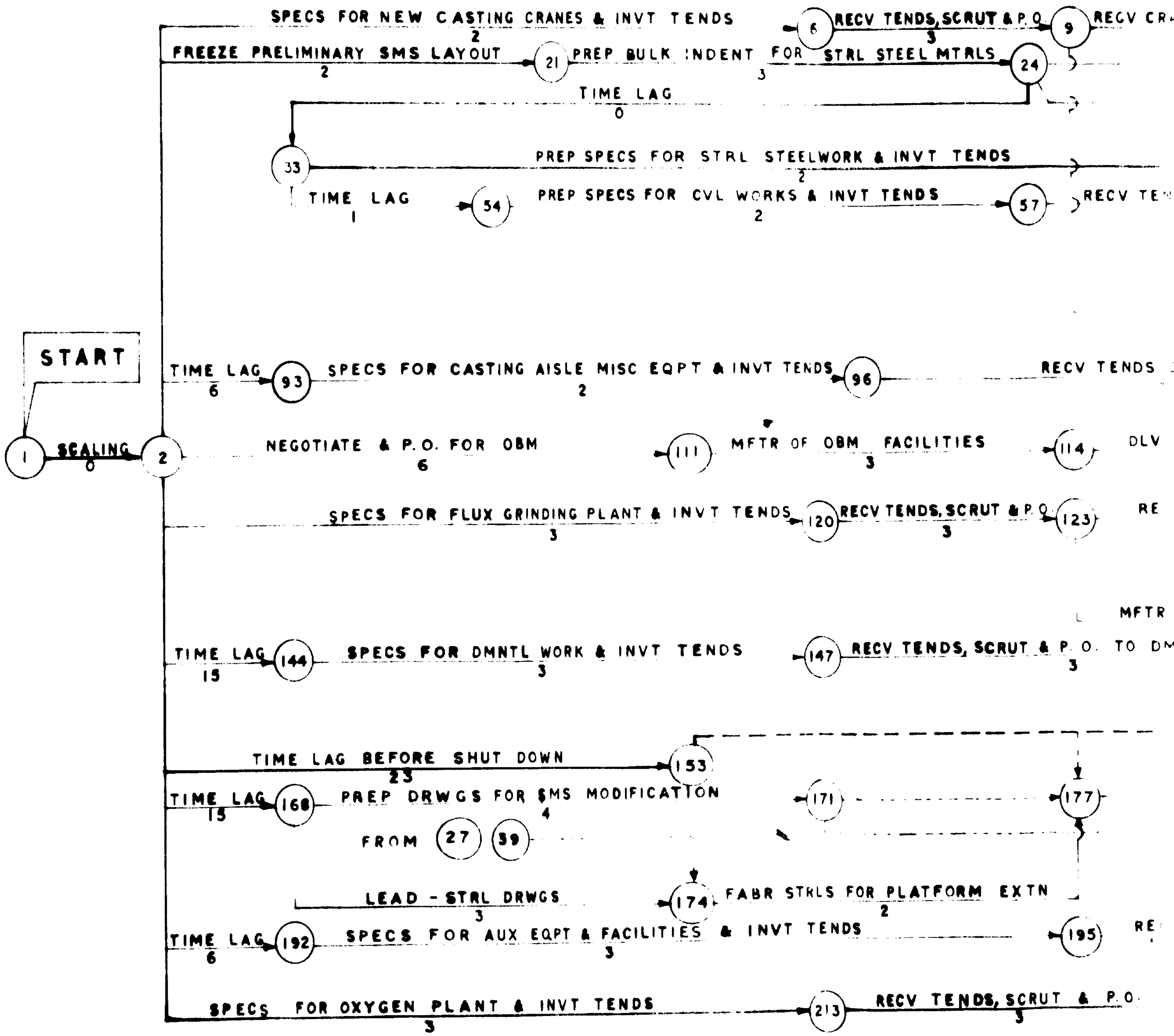
APVL	=	APPROVAL
AUX	=	AUXILIARY
BLCE	=	BALANCE
BLDG	=	BUILDING
CNTR	=	CONTRACTOR
CNVRT	=	CONVERTER
COL	=	COLUMN
CONST	=	CONSTRUCT
CRN	=	CRANE
CVL	=	CIVIL
DLVY	=	DELIVERY
DMNTL	=	DISMANTLE
DRWGS	=	DRAWING
ELECT	=	ELECTRICAL
EQPT	=	EQUIPMENT
FABR	=	FABRICATE / FABRICATION
FDN	=	FOUNDATION
G.L.	=	GROUND LEVEL
INCL	=	INCLUDING
INVT	=	INVITE
MFTR	=	MANUFACTURE
MISC	=	MISCELLANEOUS
MTRL	=	MATERIAL
P.O.	=	PLACE ORDER
PPG	=	PIPING
PREL	=	PRELIMINARY
PREP	=	PREPARE
PROC	=	PROCURE
RECV	=	RECEIVE
SCRUT	=	SCRUTINISE
SPECS	=	SPECIFICATIONS
STRL	=	STRUCTURAL
TEND	=	TENDER

DASTUR ENGINEERING INTERNATIONAL GmbH
CONSULTING ENGINEERS, DÜSSELDORF

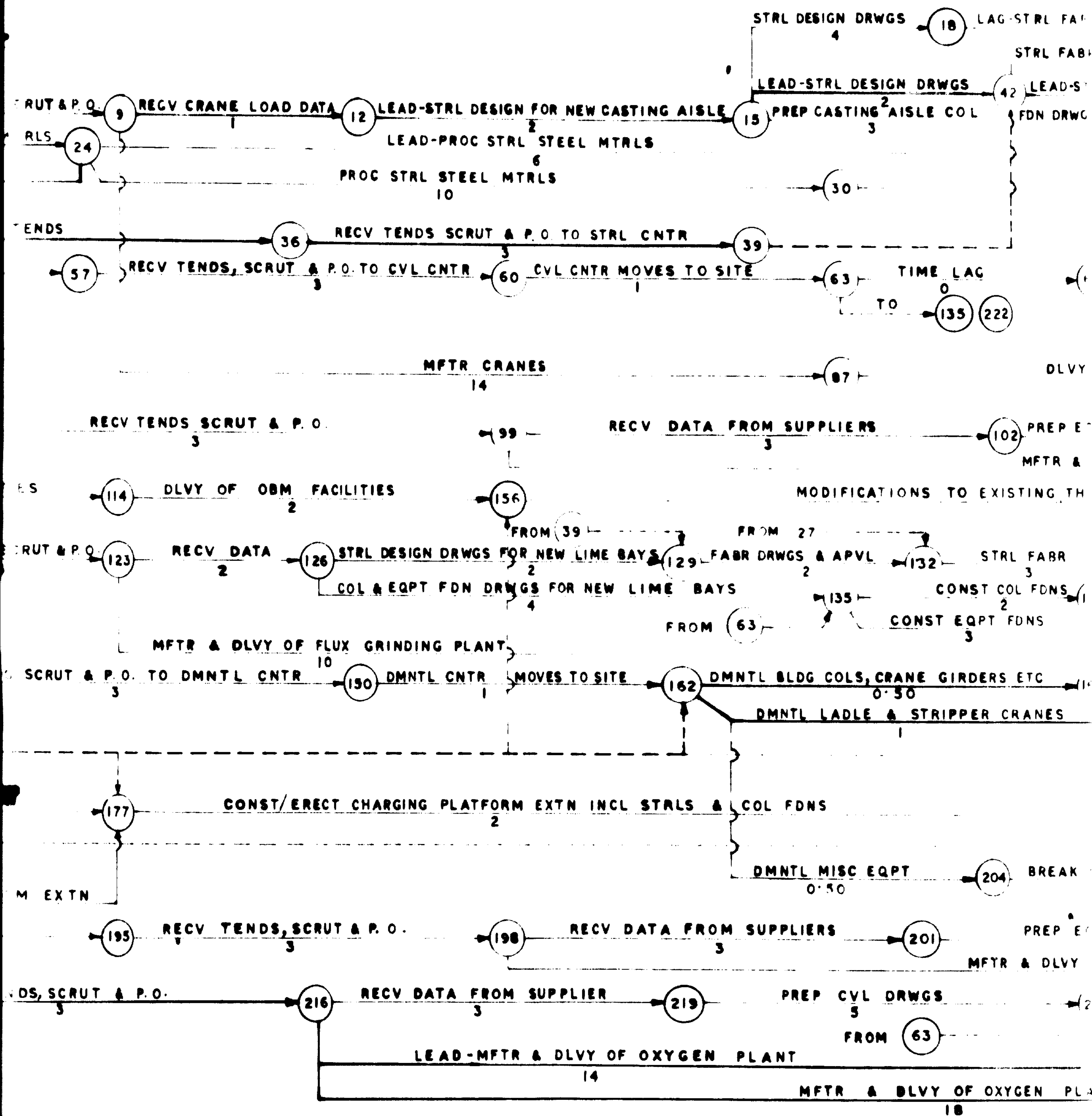
FOR:
UNITED NATIONS
INDUSTRIAL DEVELOPMENT ORGANIZATION

HELWAN IRON & STEEL PLANT
CRITICAL PATH NETWORK—ALT. 3 MODIFICATION

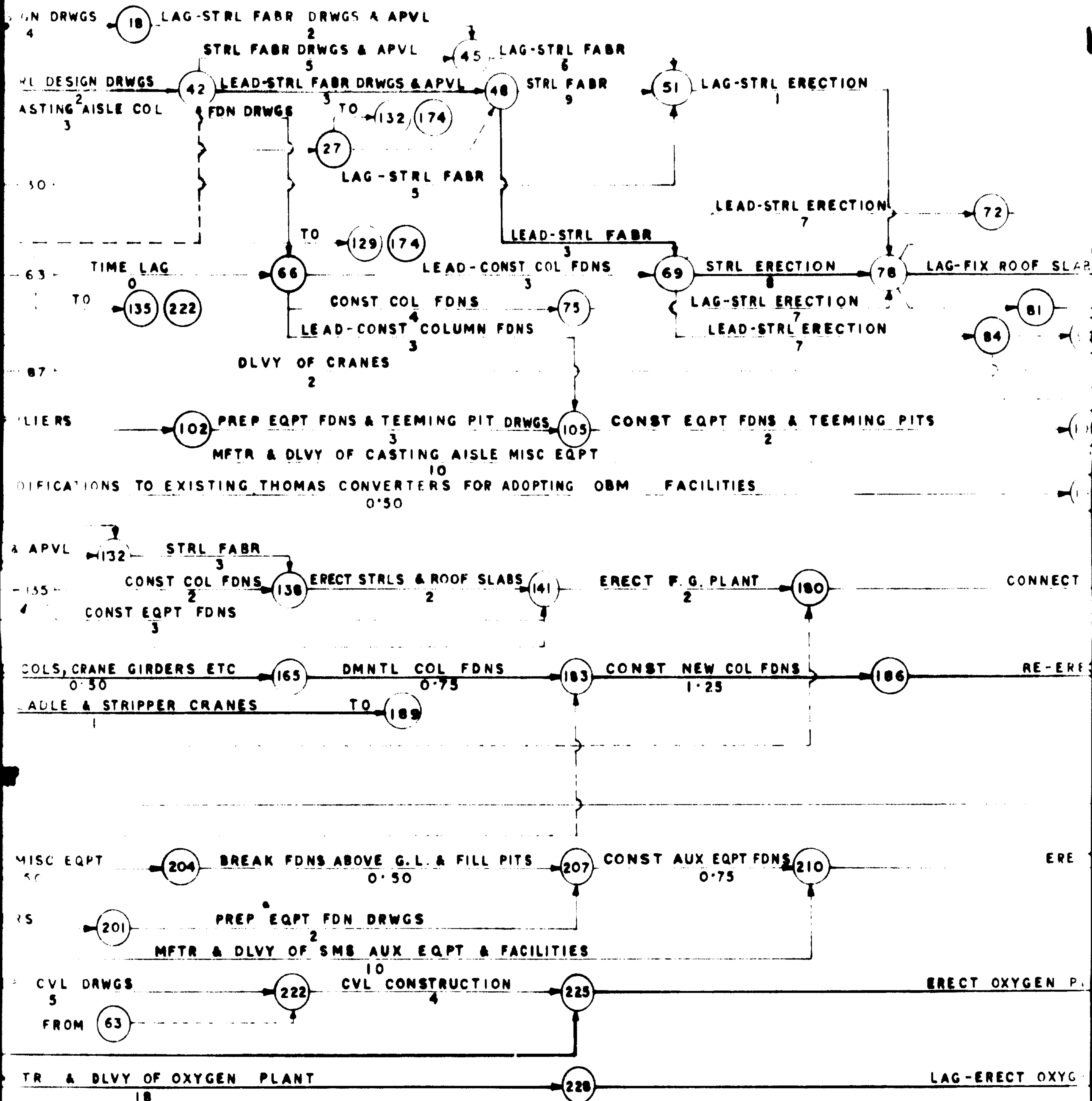
DRAWN	[signature]	18.6.72	**No. 519-6-3**
APPROVED	[signature]	22.6.72	


START
SCALING 0
SPECS FOR NEW CASTING CRANES & INVT TENDS 2
RECV TENDS, SCRUT & P.O. 3
RECV CR
FREEZE PRELIMINARY SMS LAYOUT 2
PREP BULK INDENT FOR STRL STEEL MTRLS 3
TIME LAG 0
PREP SPECS FOR STRL STEELWORK & INVT TENDS 2
TIME LAG 1
PREP SPECS FOR CVL WORKS & INVT TENDS 2
RECV TE
TIME LAG 6
SPECS FOR CASTING AISLE MISC EQPT & INVT TENDS 2
RECV TENDS
NEGOTIATE & P.O. FOR OBM 6
MFTR OF OBM FACILITIES 3
DLV
SPECS FOR FLUX GRINDING PLANT & INVT TENDS 3
RECV TENDS, SCRUT & P.O. 3
RE
MFTR
TIME LAG 15
SPECS FOR DMNTL WORK & INVT TENDS 3
RECV TENDS, SCRUT & P.O. TO DM 3
TIME LAG BEFORE SHUT DOWN 23
TIME LAG 15
PREP DRWGS FOR SMS MODIFICATION 4
FROM 27 39
LEAD - STRL DRWGS 3
FABR STRLS FOR PLATFORM EXTN 2
TIME LAG 6
SPECS FOR AUX EQPT & FACILITIES & INVT TENDS 3
RE
SPECS FOR OXYGEN PLANT & INVT TENDS 3
RECV TENDS, SCRUT & P.O. 3

SECTION 1

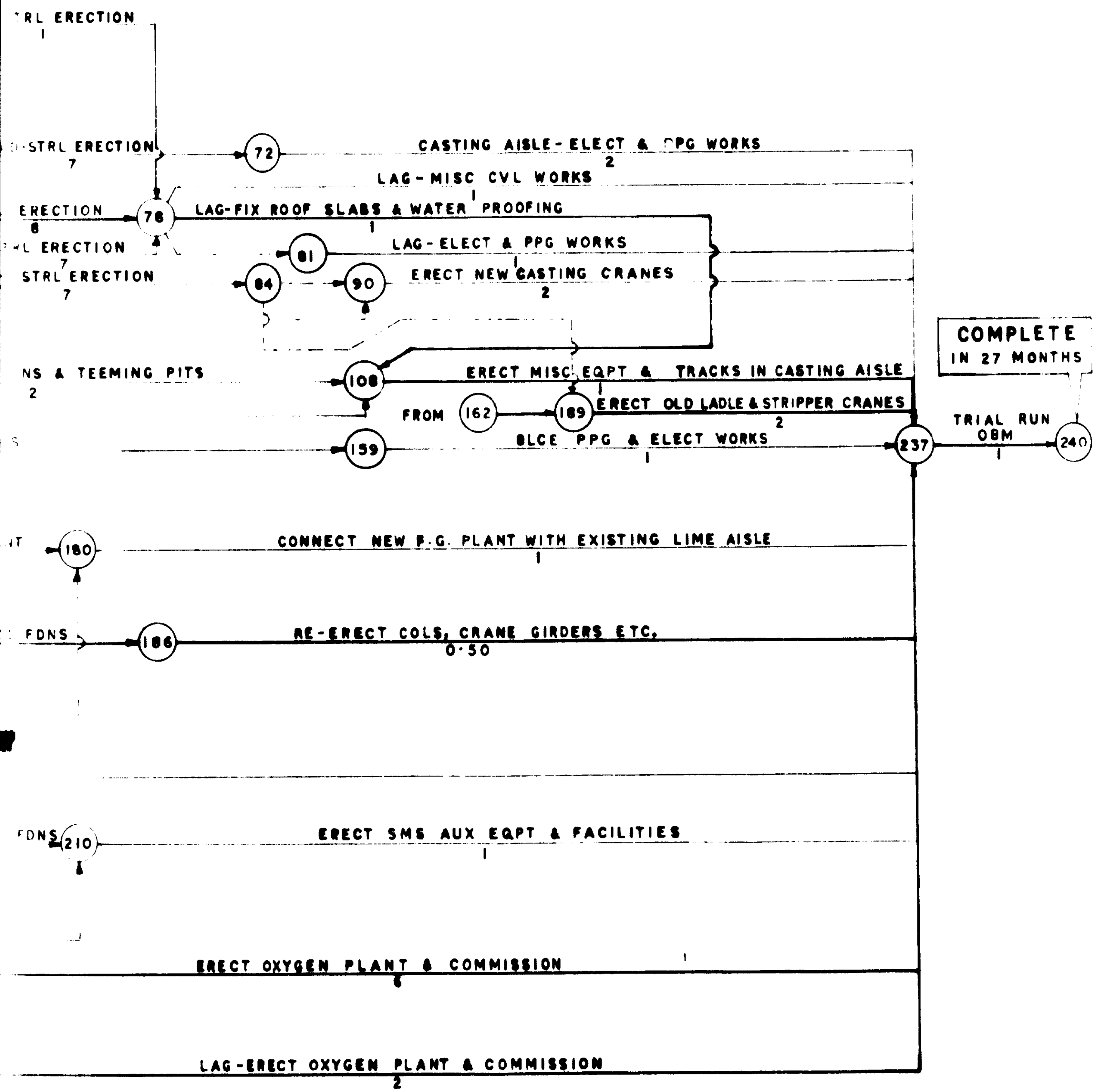

STRL DESIGN DRWGS
4
18
LAG-STRL FA
STRL FAB
LEAD-STRL DESIGN DRWGS
2
42
LEAD-S
RUT & P.O.
9
RECV CRANE LOAD DATA
1
12
LEAD-STRL DESIGN FOR NEW CASTING AISLE
2
15
PREP CASTING AISLE COL
3
FDN DRWG
RLS
24
LEAD-PROC STRL STEEL MTRLS
6
PROC STRL STEEL MTRLS
10
30
ENDS
36
RECV TENDS SCRUT & P.O TO STRL CNTR
3
39
57
RECV TENDS, SCRUT & P.O. TO CVL CNTR
3
60
CVL CNTR MOVES TO SITE
1
63
TIME LAG
0
TO
135
222
MFTR CRANES
14
87
DLVY
RECV TENDS SCRUT & P.O
3
99
RECV DATA FROM SUPPLIERS
3
102
PREP E
MFTR &
ES
114
DLVY OF OBM FACILITIES
2
156
MODIFICATIONS TO EXISTING TH
FROM 39
FROM 27
RUT & P.O.
123
RECV DATA
2
126
STRL DESIGN DRWGS FOR NEW LIME BAYS
2
129
FABR DRWGS & APVL
2
132
STRL FABR
3
COL & EQPT FDN DRWGS FOR NEW LIME BAYS
4
135
CONST COL FDNS
2
FROM
63
CONST EQPT FDNS
3
MFTR & DLVY OF FLUX GRINDING PLANT
10
SCRUT & P.O. TO DMNTL CNTR
3
150
DMNTL CNTR MOVES TO SITE
1
162
DMNTL BLDG COLS, CRANE GIRDERS ETC
0·50
DMNTL LADLE & STRIPPER CRANES
1
177
CONST/ERECT CHARGING PLATFORM EXTN INCL STRLS & COL FDNS
2
DMNTL MISC EQPT
0·50
204
BREAK
M EXTN
195
RECV TENDS, SCRUT & P.O.
3
198
RECV DATA FROM SUPPLIERS
3
201
PREP E
MFTR & DLVY
DS, SCRUT & P.O.
3
216
RECV DATA FROM SUPPLIER
3
219
PREP CVL DRWGS
5
FROM
63
LEAD-MFTR & DLVY OF OXYGEN PLANT
14
MFTR & DLVY OF OXYGEN PL
18

SECTION 2

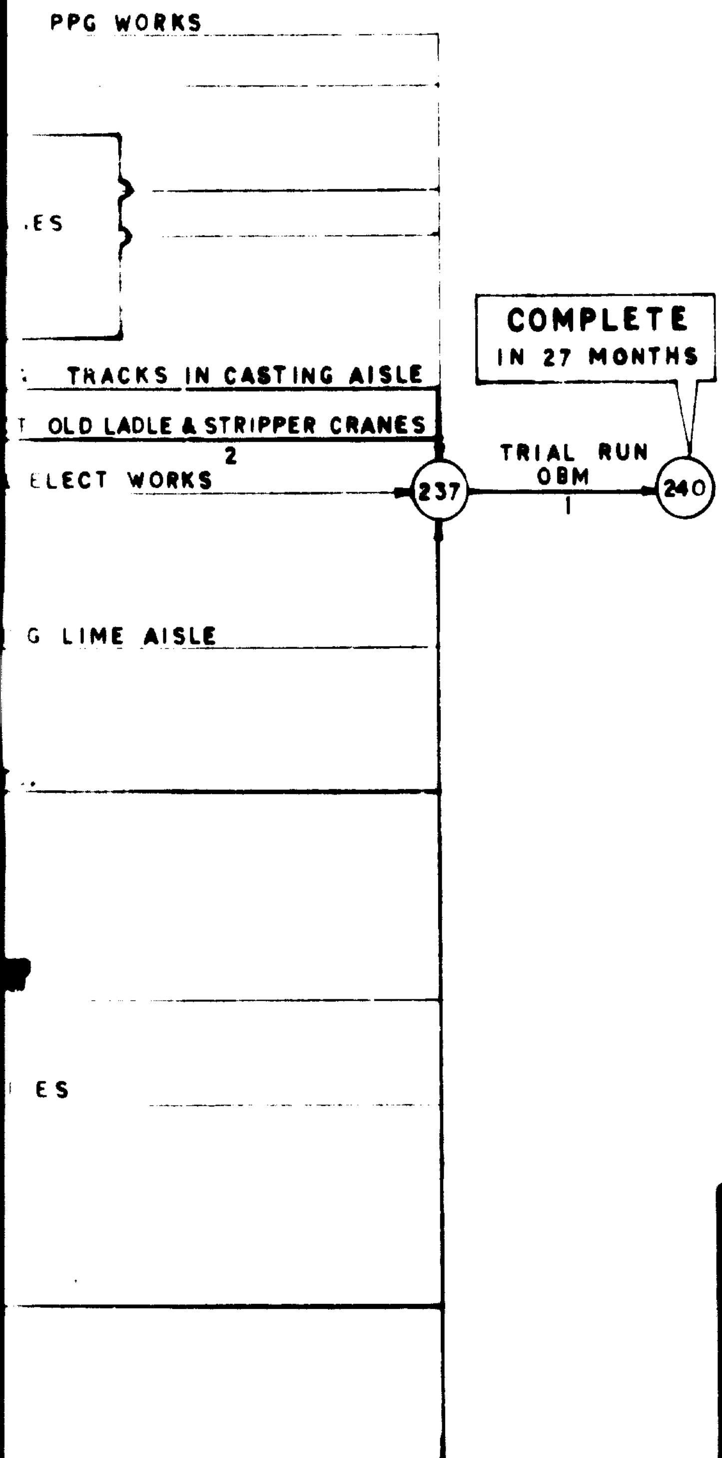


DRWGS 4
18
LAG-STRL FABR DRWGS & APVL 2
STRL FABR DRWGS & APVL 5
45
LAG-STRL FABR 6
DESIGN DRWGS 2
42
LEAD-STRL FABR DRWGS & APVL 3
48
STRL FABR 9
51
LAG-STRL ERECTION 1
ASTING AISLE COL 3
FDN DRWGS
TO 132 174
27
LAG-STRL FABR 5
LEAD-STRL ERECTION 7
72
TO 129 174
LEAD-STRL FABR 3
TIME LAG 0
66
LEAD-CONST COL FDNS 3
69
STRL ERECTION 8
78
LAG-FIX ROOF SLAB
TO 135 222
CONST COL FDNS 4
75
LAG-STRL ERECTION 7
81
LEAD-CONST COLUMN FDNS 3
LEAD-STRL ERECTION 7
84
DLVY OF CRANES 2
87
LIERS
102
PREP EQPT FDNS & TEEMING PIT DRWGS 3
105
CONST EQPT FDNS & TEEMING PITS 2
MFTR & DLVY OF CASTING AISLE MISC EQPT 10
MODIFICATIONS TO EXISTING THOMAS CONVERTERS FOR ADOPTING OBM FACILITIES 0·50
& APVL
132
STRL FABR 3
135
CONST COL FDNS 2
138
ERECT STRLS & ROOF SLABS 2
141
ERECT F. G. PLANT 2
180
CONNECT
CONST EQPT FDNS 3
COLS, CRANE GIRDERS ETC 0·50
165
DMNTL COL FDNS 0·75
183
CONST NEW COL FDNS 1·25
186
RE-ERE
LADLE & STRIPPER CRANES 1
TO 189
MISC EQPT
204
BREAK FDNS ABOVE G.L. & FILL PITS 0·50
207
CONST AUX EQPT FDNS 0·75
210
ERE
201
PREP EQPT FDN DRWGS 2
MFTR & DLVY OF SMS AUX EQPT & FACILITIES 10
CVL DRWGS 5
222
CVL CONSTRUCTION 4
225
ERECT OXYGEN P
FROM 63
TR & DLVY OF OXYGEN PLANT 18
228
LAG-ERECT OXYG

SECTION 3


STRL ERECTION 1
STRL ERECTION 7
CASTING AISLE - ELECT & PPG WORKS 2
LAG - MISC CVL WORKS 1
ERECTION 8
LAG-FIX ROOF SLABS & WATER PROOFING 1
STRL ERECTION 7
LAG - ELECT & PPG WORKS 1
STRL ERECTION 7
ERECT NEW CASTING CRANES 2
COMPLETE IN 27 MONTHS
NS & TEEMING PITS 2
ERECT MISC EQPT & TRACKS IN CASTING AISLE 1
FROM
ERECT OLD LADLE & STRIPPER CRANES 2
TRIAL RUN OBM 1
BLCE PPG & ELECT WORKS 1
CONNECT NEW P.G. PLANT WITH EXISTING LIME AISLE 1
FDNS
RE-ERECT COLS, CRANE GIRDERS ETC. 0·50
FDNS
ERECT SMS AUX EQPT & FACILITIES 1
ERECT OXYGEN PLANT & COMMISSION 6
LAG-ERECT OXYGEN PLANT & COMMISSION 2
72
78
81
84
90
108
162
189
159
237
240
180
186
210

SECTION 4



NOTES:

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DLVY	=	DELIVERY
DMNTL	=	DISMANTLE
DRWG	=	DRAWING
ELECT	=	ELECTRICAL
EQPT	=	EQUIPMENT
EXTN	=	EXTENSION
FABR	=	FABRICATE/FABRICATION
FDN	=	FOUNDATION
F. G.	=	FLUX GRINDING
G. L.	=	GROUND LEVEL
INCL	=	INCLUDING
INVT	=	INVITE
MFTR	=	MANUFACTURE
MISC	=	MISCELLANEOUS
MTRL	=	MATERIAL
P. O.	=	PLACE ORDER
PREL	=	PRELIMINARY
PREP	=	PREPARE
PROC	=	PROCURE
RECV	=	RECEIVE
SCRUT	=	SCRUTINISE
SMS	=	STEELMELT SHOP
SPECS	=	SPECIFICATIONS
STRL	=	STRUCTURAL
TEND	=	TENDER

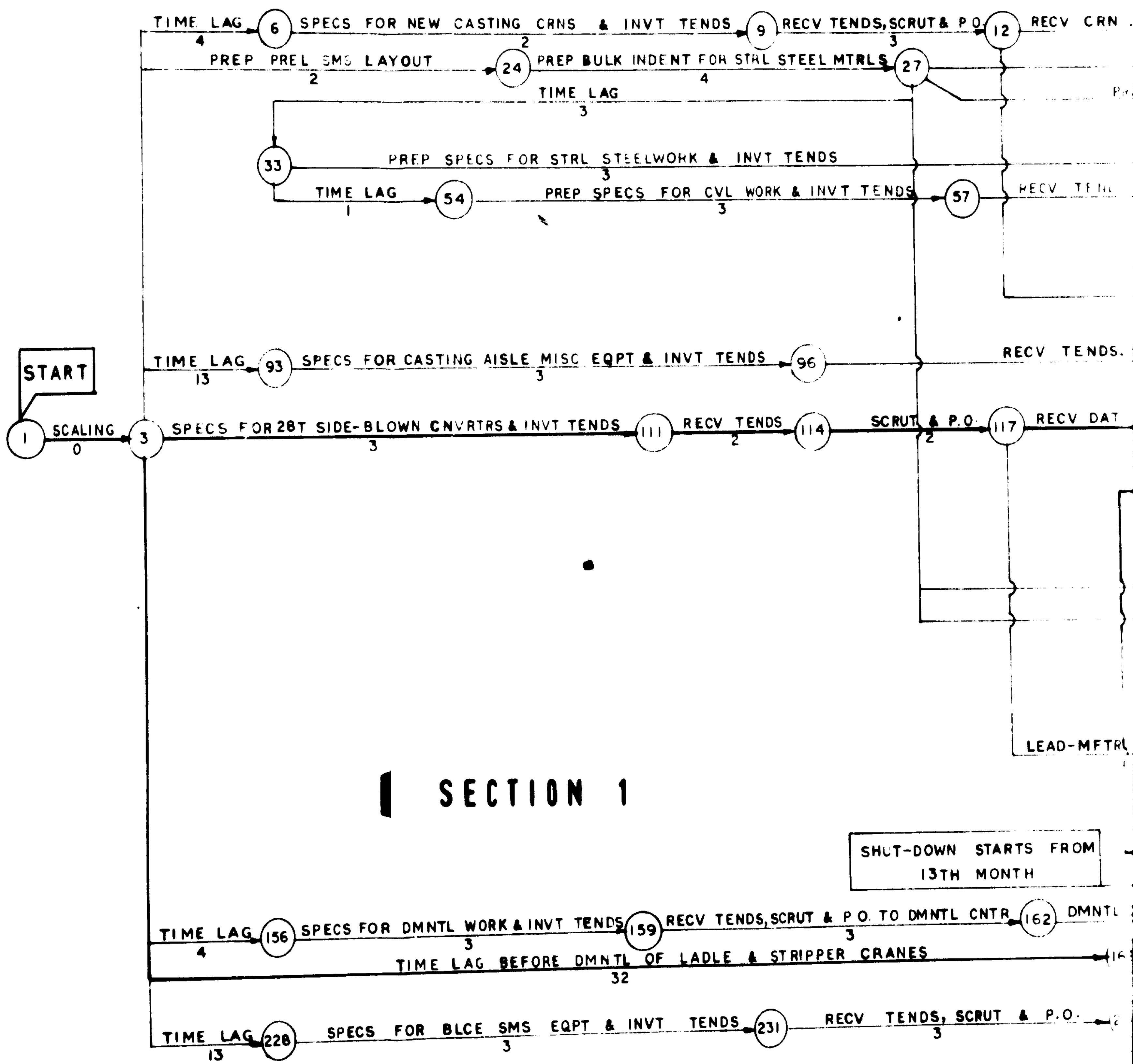
SECTION 5

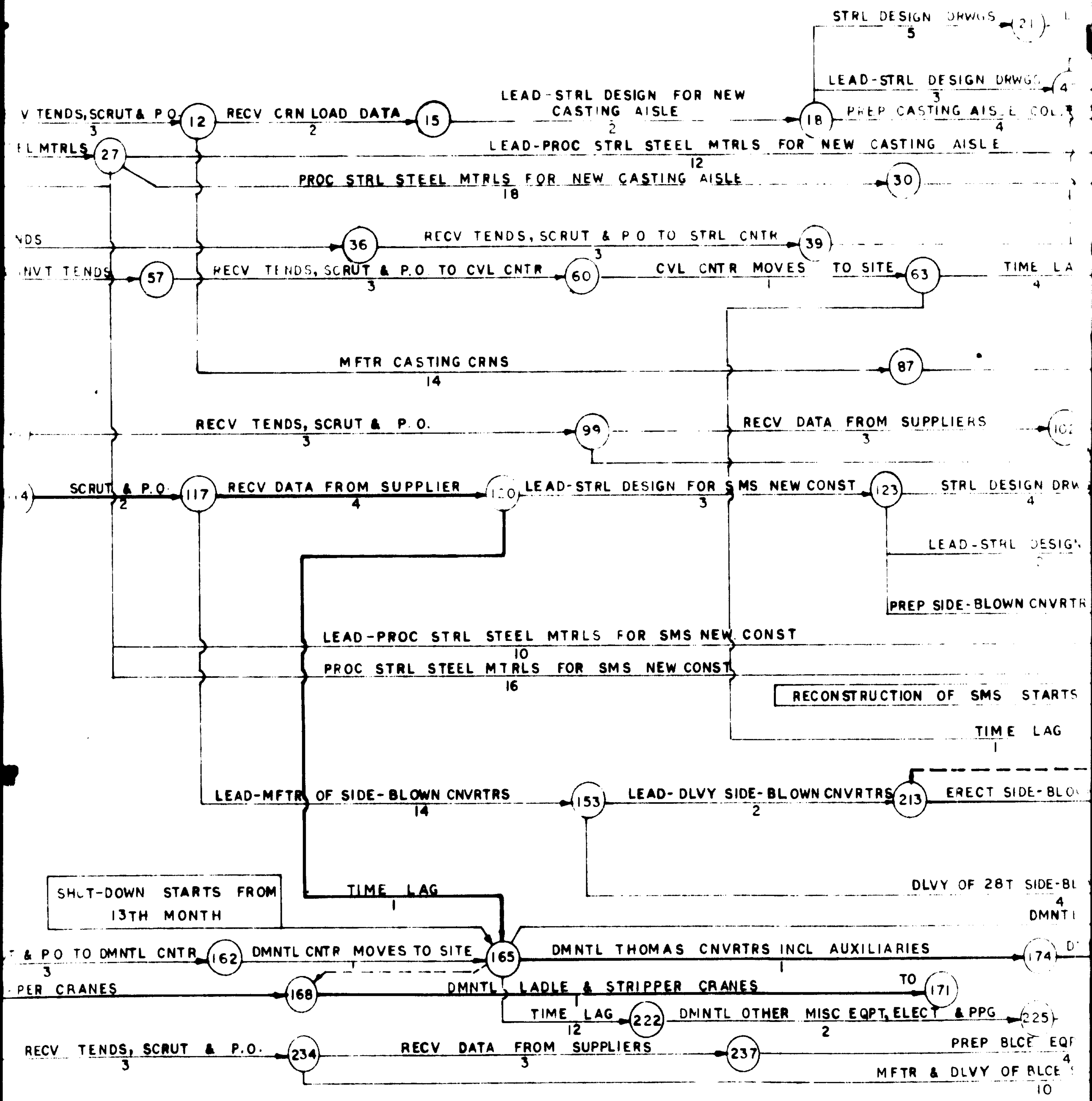
DASTUR ENGINEERING INTERNATIONAL GmbH
CONSULTING ENGINEERS, DÜSSELDORF

FOR: **UNITED NATIONS INDUSTRIAL DEVELOPMENT ORGANIZATION**

HELWAN IRON & STEEL PLANT
CRITICAL PATH NETWORK-ALT. 4 MODIFICATION

DRAWN	Mondal	8/6/72	No. 519-6-4
APPROVED	[illegible]	12.6.72	


START
SCALING
0
TIME LAG
4
SPECS FOR NEW CASTING CRNS & INVT TENDS
2
RECV TENDS, SCRUT & P.O.
3
RECV CRN
PREP PREL SMS LAYOUT
2
PREP BULK INDENT FOR STRL STEEL MTRLS
4
TIME LAG
3
PREP SPECS FOR STRL STEELWORK & INVT TENDS
3
TIME LAG
1
PREP SPECS FOR CVL WORK & INVT TENDS
3
TIME LAG
13
SPECS FOR CASTING AISLE MISC EQPT & INVT TENDS
3
RECV TENDS.
SPECS FOR 28T SIDE-BLOWN CNVRTRS & INVT TENDS
3
RECV TENDS
2
SCRUT & P.O.
2
RECV DAT
LEAD-MFTRL
SECTION 1
SHUT-DOWN STARTS FROM 13TH MONTH
TIME LAG
4
SPECS FOR DMNTL WORK & INVT TENDS
3
RECV TENDS, SCRUT & P.O. TO DMNTL CNTR
3
DMNTL
TIME LAG BEFORE DMNTL OF LADLE & STRIPPER CRANES
32
TIME LAG
13
SPECS FOR BLCE SMS EQPT & INVT TENDS
3
RECV TENDS, SCRUT & P.O.
3
1
3
6
9
12
24
27
33
54
57
93
96
111
114
117
156
159
162
228
231


STRL DESIGN DRWGS 5
LEAD-STRL DESIGN DRWGS 3
LEAD-STRL DESIGN FOR NEW CASTING AISLE 2
PREP CASTING AISLE COL 4
V TENDS, SCRUT & P.O. 3
RECV CRN LOAD DATA 2
LEAD-PROC STRL STEEL MTRLS FOR NEW CASTING AISLE 12
PROC STRL STEEL MTRLS FOR NEW CASTING AISLE 18
RECV TENDS, SCRUT & P.O TO STRL CNTR 3
RECV TENDS, SCRUT & P.O. TO CVL CNTR 3
CVL CNTR MOVES TO SITE 1
TIME LAG 4
MFTR CASTING CRNS 14
RECV TENDS, SCRUT & P.O. 3
RECV DATA FROM SUPPLIERS 3
SCRUT & P.O. 2
RECV DATA FROM SUPPLIER 4
LEAD-STRL DESIGN FOR SMS NEW CONST 3
STRL DESIGN DRW 4
LEAD-STRL DESIGN
PREP SIDE-BLOWN CNVRTR
LEAD-PROC STRL STEEL MTRLS FOR SMS NEW CONST 10
PROC STRL STEEL MTRLS FOR SMS NEW CONST 16
RECONSTRUCTION OF SMS STARTS
TIME LAG 1
LEAD-MFTR OF SIDE-BLOWN CNVRTRS 14
LEAD-DLVY SIDE-BLOWN CNVRTRS 2
ERECT SIDE-BLO
DLVY OF 28T SIDE-BL 4
SHUT-DOWN STARTS FROM 13TH MONTH
TIME LAG 1
DMNTL
& PO TO DMNTL CNTR 3
DMNTL CNTR MOVES TO SITE 1
DMNTL THOMAS CNVRTRS INCL AUXILIARIES 1
PER CRANES
DMNTL LADLE & STRIPPER CRANES TO 1
TIME LAG 12
DMNTL OTHER MISC EQPT, ELECT & PPG 2
RECV TENDS, SCRUT & P.O. 3
RECV DATA FROM SUPPLIERS 3
PREP BLCE EQP 4
MFTR & DLVY OF BLCE 10
12
15
18
21
27
30
36
39
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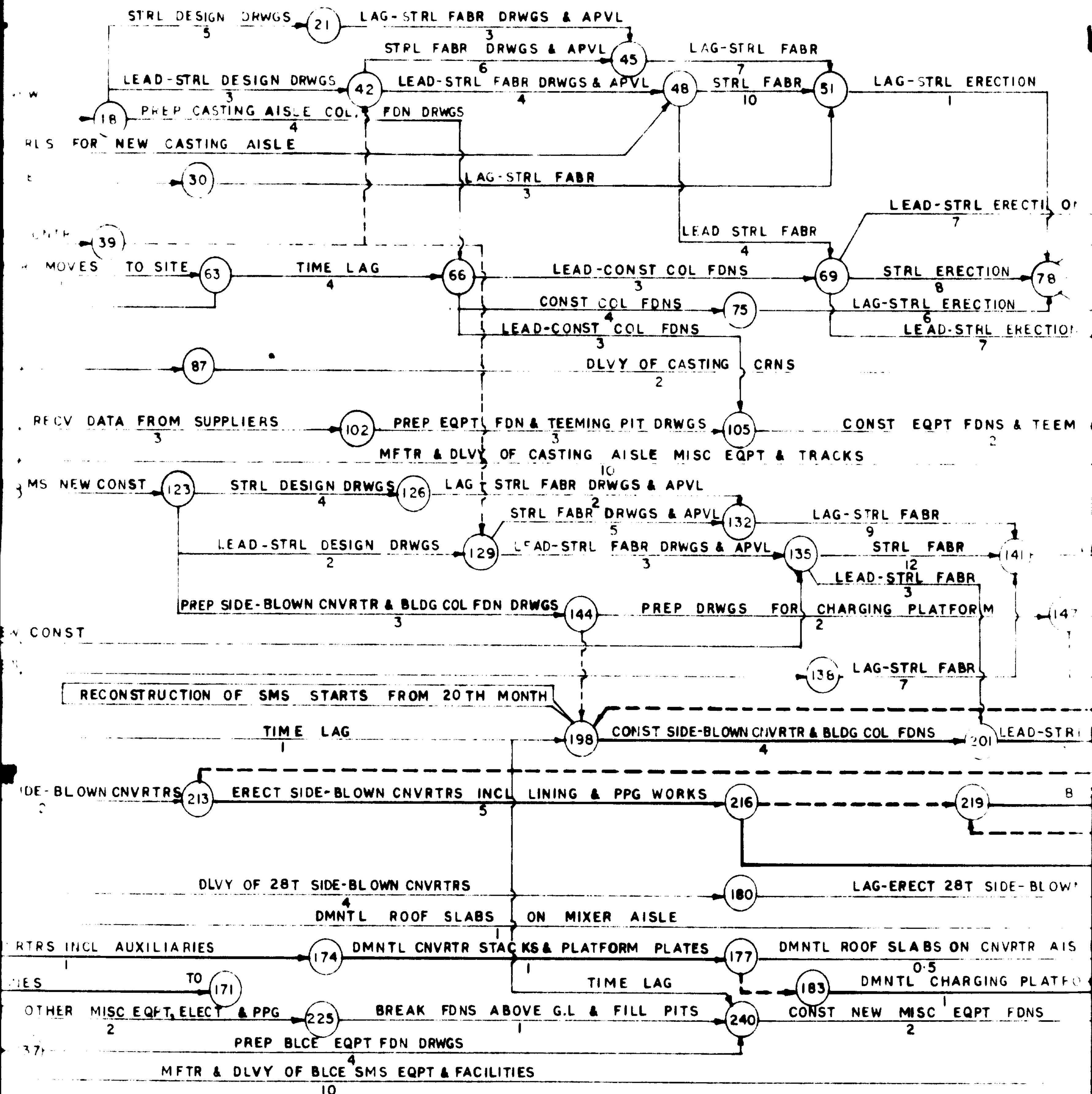
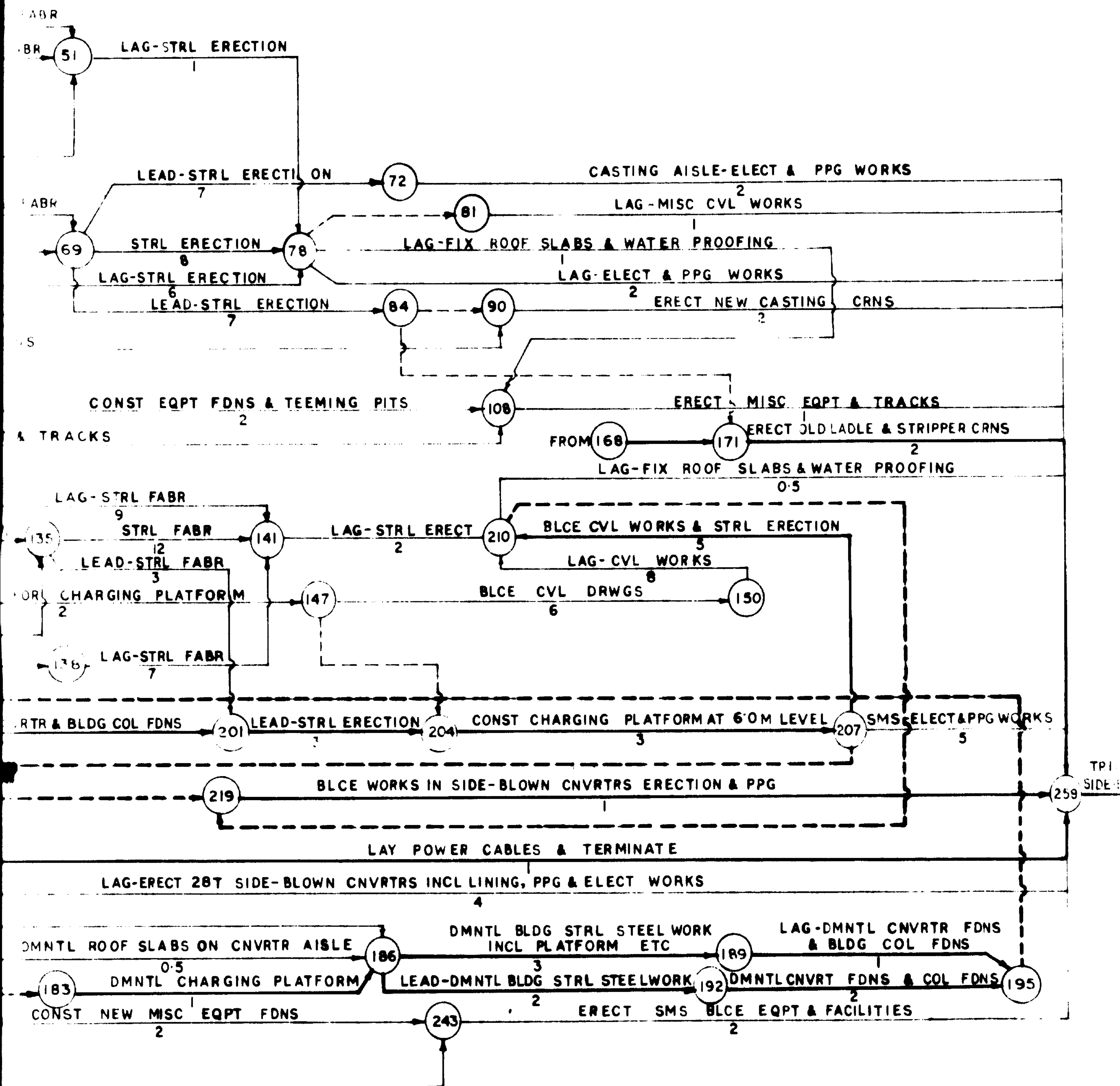
225
234
237

SECTION 2



STRL DESIGN DRWGS 5
LAG-STRL FABR DRWGS & APVL 3
STRL FABR DRWGS & APVL 6
LAG-STRL FABR 7
LEAD-STRL DESIGN DRWGS 3
LEAD-STRL FABR DRWGS & APVL 4
STRL FABR 10
LAG-STRL ERECTION 1
PREP CASTING AISLE COL. FDN DRWGS 4
RLS FOR NEW CASTING AISLE
LAG-STRL FABR 3
LEAD-STRL ERECTION 7
LEAD STRL FABR 4
MOVES TO SITE
TIME LAG 4
LEAD-CONST COL FDNS 3
STRL ERECTION 8
CONST COL FDNS 4
LAG-STRL ERECTION 6
LEAD-CONST COL FDNS 3
LEAD-STRL ERECTION 7
DLVY OF CASTING CRNS 2
RECV DATA FROM SUPPLIERS 3
PREP EQPT FDN & TEEMING PIT DRWGS 3
CONST EQPT FDNS & TEEM 2
MFTR & DLVY OF CASTING AISLE MISC EQPT & TRACKS 10
MS NEW CONST
STRL DESIGN DRWGS 4
LAG STRL FABR DRWGS & APVL 2
STRL FABR DRWGS & APVL 5
LAG-STRL FABR 9
LEAD-STRL DESIGN DRWGS 2
LEAD-STRL FABR DRWGS & APVL 3
STRL FABR 12
LEAD-STRL FABR 3
PREP SIDE-BLOWN CNVRTR & BLDG COL FDN DRWGS 3
PREP DRWGS FOR CHARGING PLATFORM 2
CONST
LAG-STRL FABR 7
RECONSTRUCTION OF SMS STARTS FROM 20TH MONTH
TIME LAG 1
CONST SIDE-BLOWN CNVRTR & BLDG COL FDNS 4
LEAD-STR
IDE-BLOWN CNVRTRS
ERECT SIDE-BLOWN CNVRTRS INCL LINING & PPG WORKS 5
8
DLVY OF 28T SIDE-BLOWN CNVRTRS 4
LAG-ERECT 28T SIDE-BLOW
DMNTL ROOF SLABS ON MIXER AISLE 1
RTRS INCL AUXILIARIES 1
DMNTL CNVRTR STACKS & PLATFORM PLATES 1
DMNTL ROOF SLABS ON CNVRTR AIS 0.5
TO
TIME LAG
DMNTL CHARGING PLATF 1
OTHER MISC EQPT, ELECT & PPG 2
BREAK FDNS ABOVE G.L & FILL PITS 1
CONST NEW MISC EQPT FDNS 2
PREP BLCE EQPT FDN DRWGS 4
MFTR & DLVY OF BLCE SMS EQPT & FACILITIES 10

SECTION 3



LAG-STRL ERECTION
1
LEAD-STRL ERECTION
7
CASTING AISLE-ELECT & PPG WORKS
2
LAG-MISC CVL WORKS
1
STRL ERECTION
8
LAG-FIX ROOF SLABS & WATER PROOFING
1
LAG-STRL ERECTION
6
LAG-ELECT & PPG WORKS
2
LEAD-STRL ERECTION
7
ERECT NEW CASTING CRNS
2
CONST EQPT FDNS & TEEMING PITS
2
& TRACKS
ERECT MISC EQPT & TRACKS
1
FROM
ERECT OLD LADLE & STRIPPER CRNS
2
LAG-FIX ROOF SLABS & WATER PROOFING
0·5
LAG-STRL FABR
9
STRL FABR
12
LEAD-STRL FABR
3
LAG-STRL ERECT
2
BLCE CVL WORKS & STRL ERECTION
5
LAG-CVL WORKS
8
CHARGING PLATFORM
2
BLCE CVL DRWGS
6
LAG-STRL FABR
7
RTR & BLDG COL FDNS
LEAD-STRL ERECTION
CONST CHARGING PLATFORM AT 6·0M LEVEL
3
SMS ELECT & PPG WORKS
5
BLCE WORKS IN SIDE-BLOWN CNVRTRS ERECTION & PPG
1
LAY POWER CABLES & TERMINATE
1
LAG-ERECT 28T SIDE-BLOWN CNVRTRS INCL LINING, PPG & ELECT WORKS
4
DMNTL ROOF SLABS ON CNVRTR AISLE
0·5
DMNTL BLDG STRL STEEL WORK INCL PLATFORM ETC
3
LAG-DMNTL CNVRTR FDNS & BLDG COL FDNS
1
DMNTL CHARGING PLATFORM
1
LEAD-DMNTL BLDG STRL STEELWORK
2
DMNTL CNVRT FDNS & COL FDNS
2
CONST NEW MISC EQPT FDNS
2
ERECT SMS BLCE EQPT & FACILITIES
2
51
69
72
78
81
84
90
108
135
138
141
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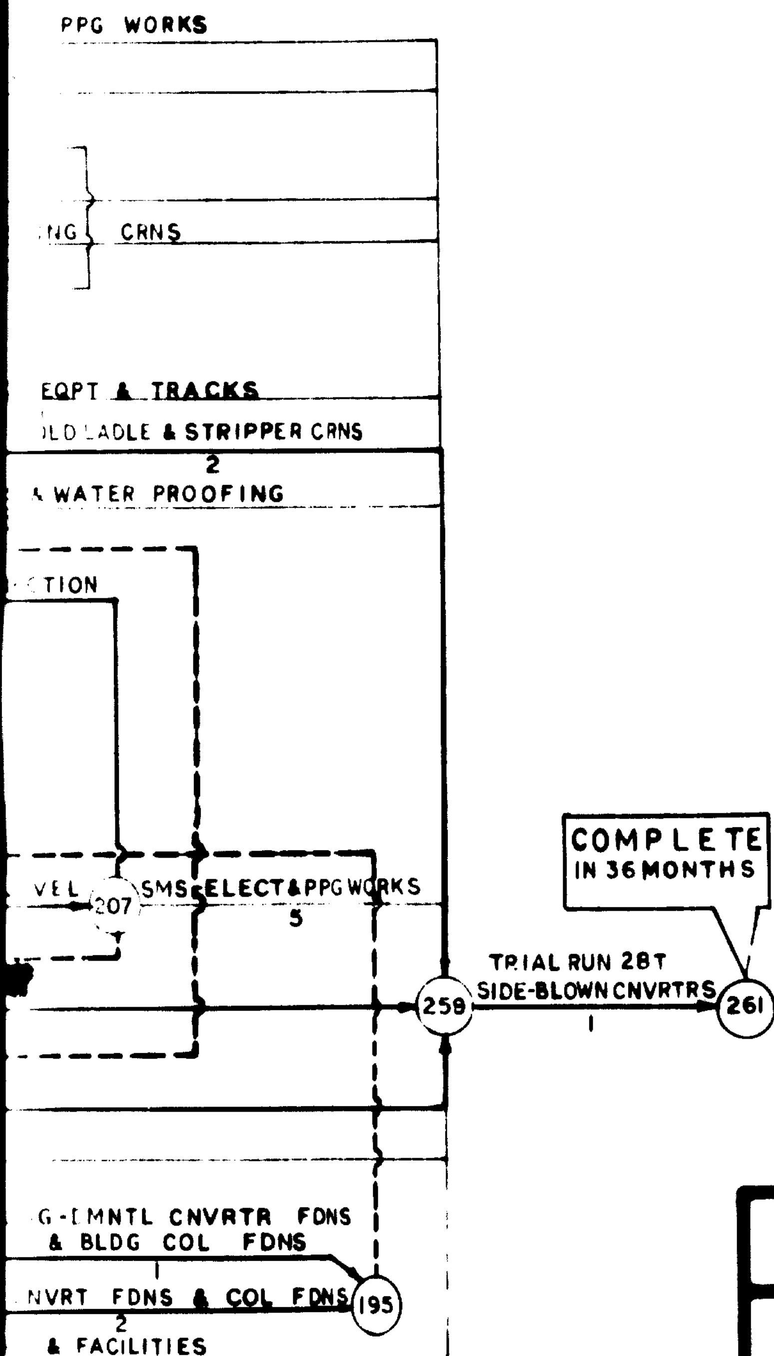
243
259

SECTION 4



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STRL	=	STRUCTURAL
TEND	=	TENDER
MISC	=	MISCELLANEOUS

SECTION 5

DASTUR ENGINEERING INTERNATIONAL GmbH
CONSULTING ENGINEERS, DÜSSELDORF

UNITED NATIONS
INDUSTRIAL DEVELOPMENT ORGANIZATION

HELWAN IRON & STEEL PLANT
CRITICAL PATH NETWORK-ALT. 5 MODIFICATION

DRAWN	[signature]	9.6.72	No. 519-6-5
APPROVED	[signature]	12.6.72	

C-370

80.12.10